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Looking at Transportation in New Ways

Burkhard Huhnke VWGoA Electronics Research Lab, Palo Alto CA

Hot Chips August 2010

Audi BENTLEY BUGATTI VW Credit, Inc. ERL

Global research and development program

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VTT VOLKSWAGEN Group Technical Representative Tokyo



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Worldwide collaboration

- ❑ Knowledge network
- ❑ Teamwork of experts worldwide
- ❑ Driving innovations
- ❑ Comparison of concepts
- ❑ Best solutions in car

VTT VOLKSWAGEN Group Technical Representative Tokyo

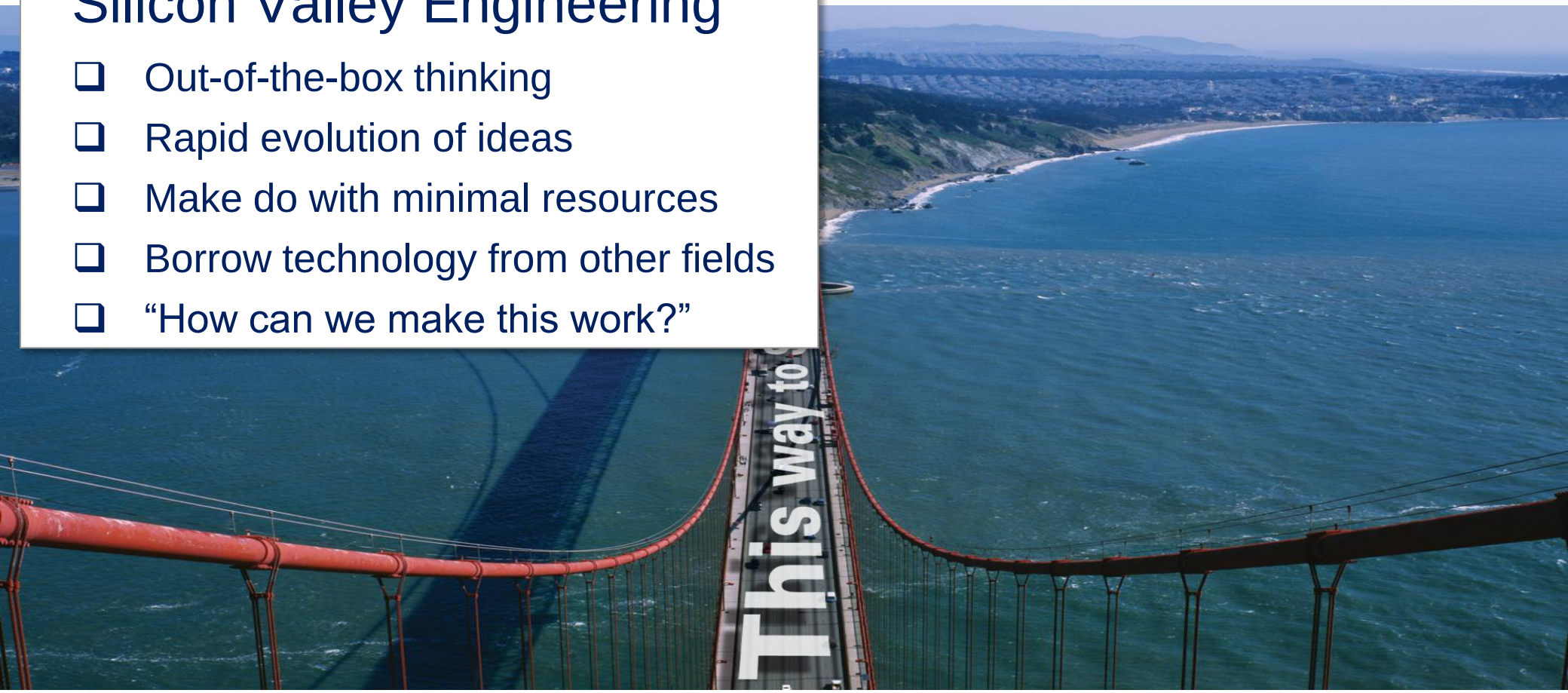


The ERL is a Bridge

The ERL is a Bridge

Silicon Valley Engineering

- Out-of-the-box thinking
- Rapid evolution of ideas
- Make do with minimal resources
- Borrow technology from other fields
- “How can we make this work?”



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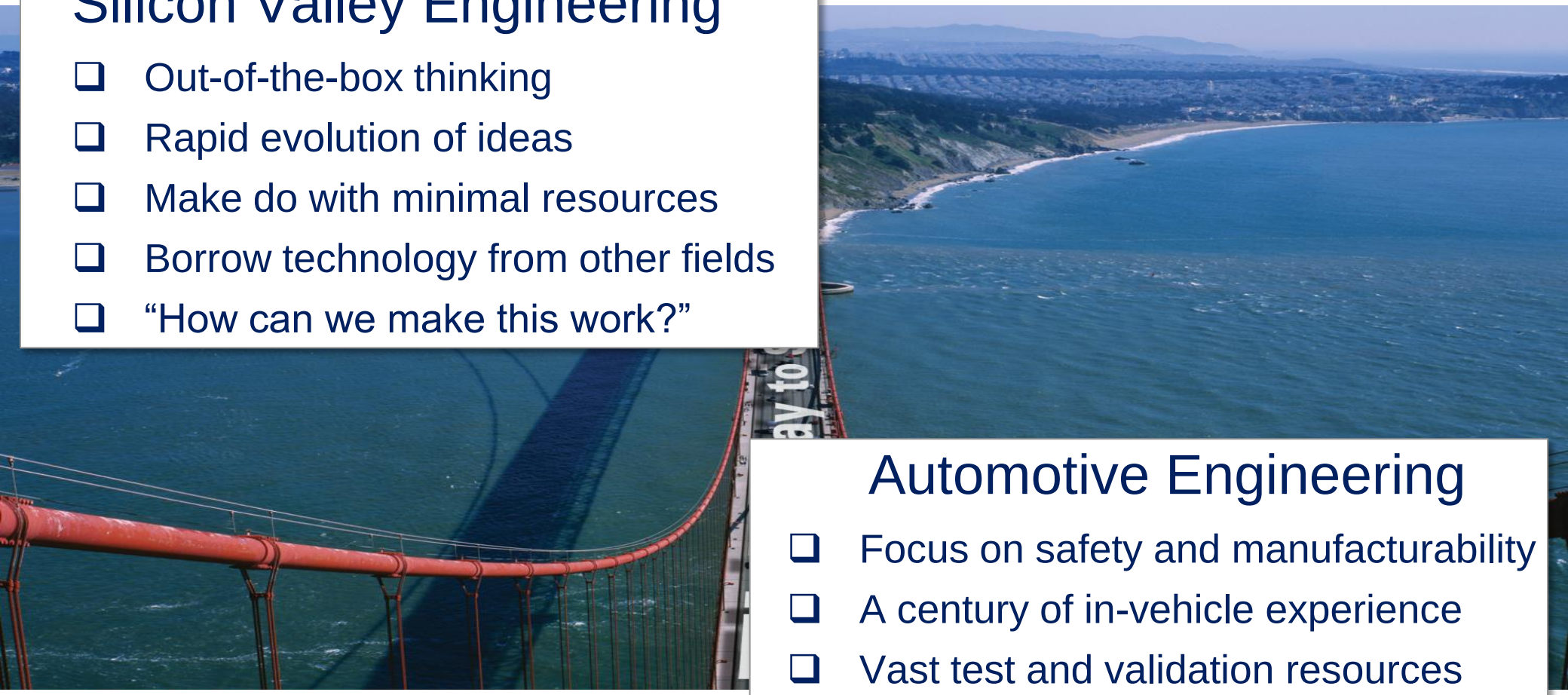

Automotive Engineering

- Focus on safety and manufacturability
- A century of in-vehicle experience
- Vast test and validation resources
- Trusted automotive technology
- “Prove that it works in all situations”

The ERL is a Bridge

Silicon Valley Engineering

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- "How can v

ERL Engineering

- New, bold ideas and technology
- Meeting rigorous automotive requirements

Automotive Engineering

- Focus on safety and manufacturability
- A century of in-vehicle experience
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- "Prove that it works in all situations"

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The Electronics Research Lab – Driving The Future

The Electronics Research Lab – Driving The Future

Driver assistance systems

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Driver assistance systems

Connected Car

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Driver assistance systems

Connected Car

Human Machine Interface

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eMobility development

Global Challenges

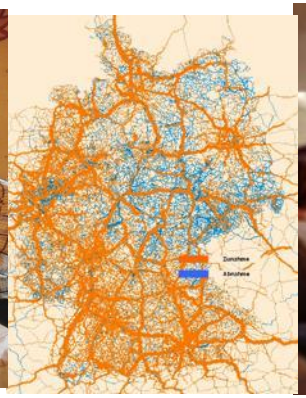
Lack of space

... in Los Angeles

... in Dhaka

poor or rich
- both have to wait -

Challenges for Society


Decreasing energy resources at a rising cost

Increasingly complex traffic situations

Increasing need for safety

Challenges of the future

- Individual customer requirements
- Income polarisation
- Demographic change

- Urbanisation
- Increasing traffic load
- Seamless mobility

Society

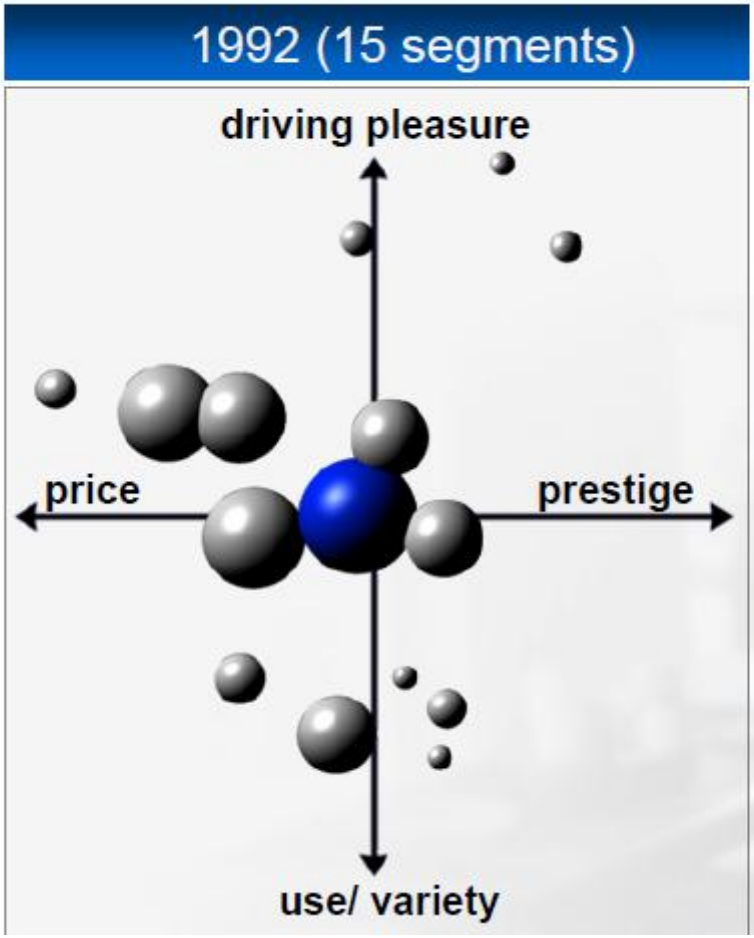
Mobility **Energy**

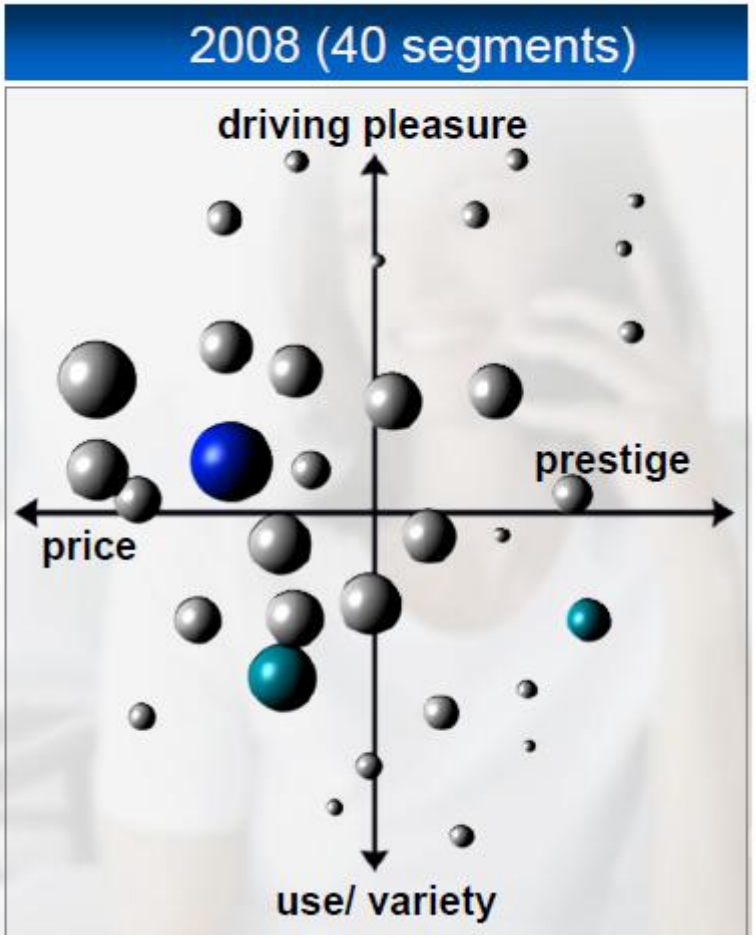
Safety

- Climate change
- CO_2
- Peak of oil

- Increasing vehicle number
- Legal requirements
- New markets

Increasing vehicle segments and different customer requirements





Electronics enables new functions but requires a novel interpretation of usability

Driving in the thirties: 30`
-Gas valve
-Fuel
-Outside temperature-> - ignition
- fuel injection
- Choke
- decompress
- search OT
- crank
-Control all engine data (watertemp, oiltemp, oil level, oilpressure,…)
-control all engine parameters
-dose cooling air

Driving in the eighties: 80`

-unlock
-switch on ignition
-turn on radio
-put on safety belt
-start engine
-drive
-no warning = no need to act

Driving in the 21st century:

-enter
-Input destination
-Select entertainment
-Put on safety belt
-Start engine
-Select and configure assistance
-drive
-Monitor assistance functions
-Follow infotainment suggestions – travel guide, traffic info etc.
- Use mobile devices?

VW Beetle in 1949: a historical E/E architecture

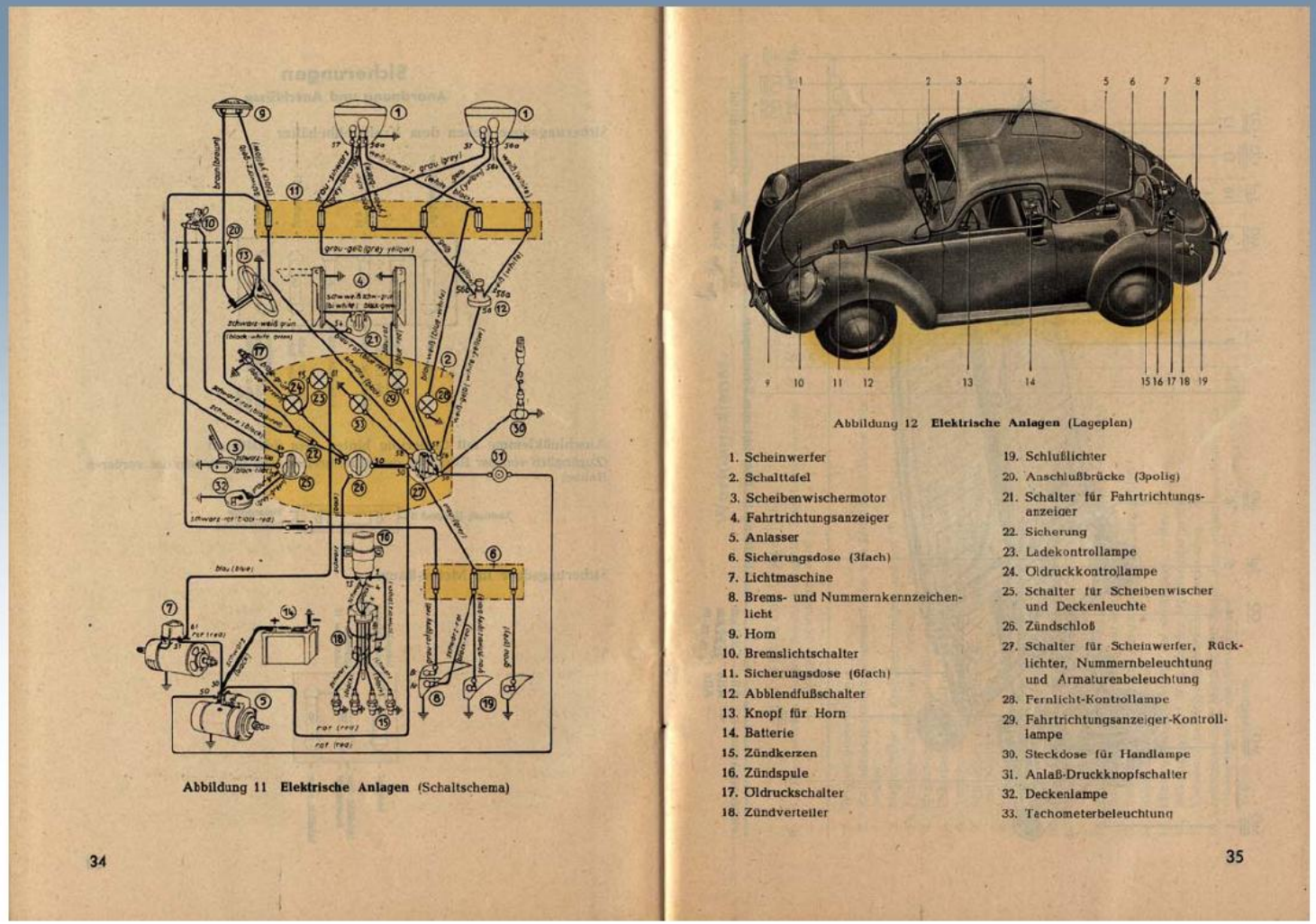


Abbildung 11 **Elektrische Anlagen** (Schaltschema)

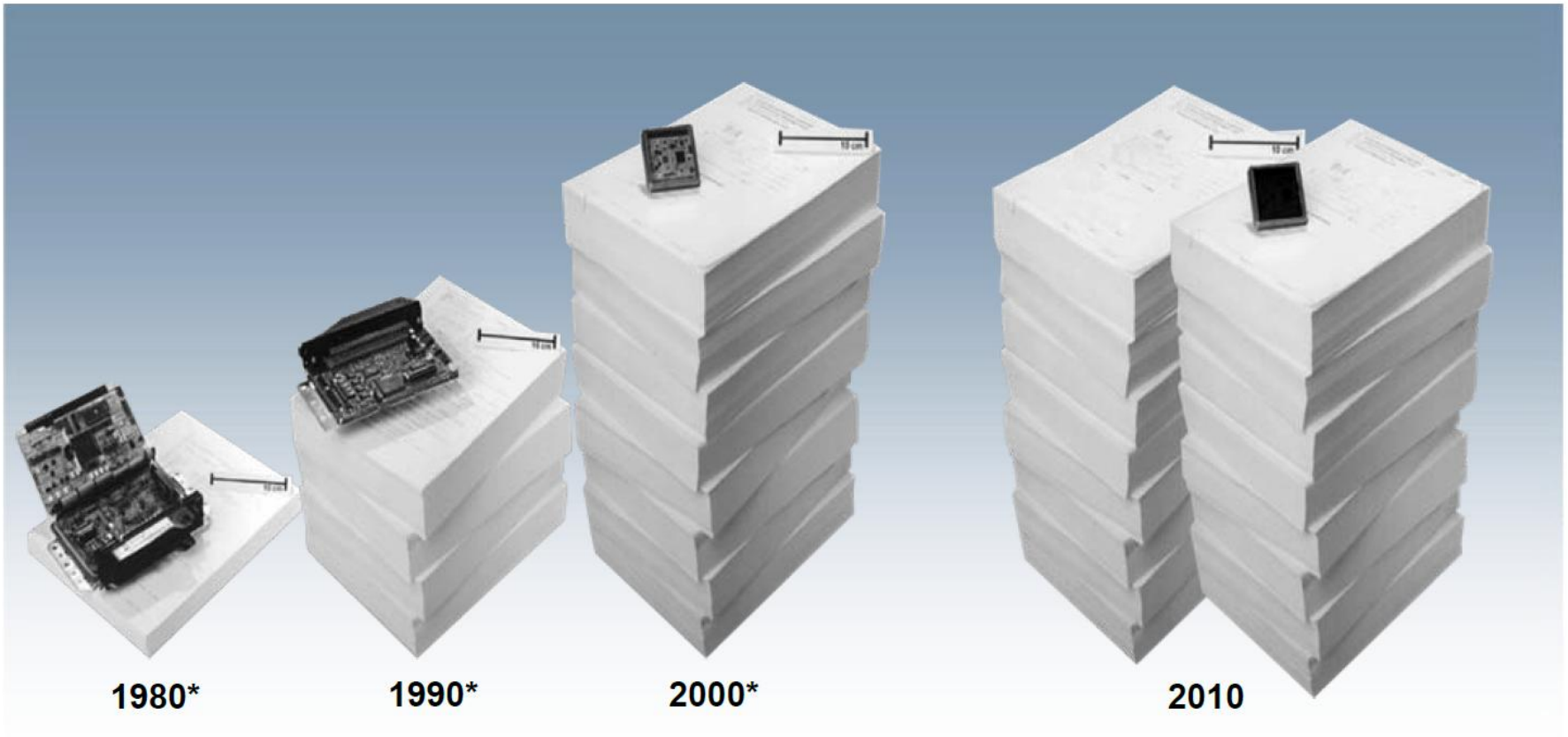
34

Abbildung 12 **Elektrische Anlagen** (Lageplan)

1. Scheinwerfer
2. Schalttafel
3. Scheibenwischermotor
4. Fahrtrichtungsanzeiger
5. Anlasser
6. Sicherungsdose (3fach)
7. Lichtmaschine
8. Brems- und Nummernkennzeichenlicht
9. Horn
10. Bremslichtschalter
11. Sicherungsdose (6fach)
12. Abblendfußschalter
13. Knopf für Horn
14. Batterie
15. Zündkerzen
16. Zündspule
17. Oldruckschalter
18. Zündverteiler
19. Schlußlichter
20. Anschlußbrücke (3polig)
21. Schalter für Fahrtrichtungsanzeiger
22. Sicherung
23. Ladekontrollampe
24. Oldruckkontrollampe
25. Schalter für Scheibenwischer und Deckenleuchte
26. Zündschloß
27. Schalter für Scheinwerfer, Rücklichter, Nummernbeleuchtung und Armaturenbeleuchtung
28. Fernlicht-Kontrollampe
29. Fahrtrichtungsanzeiger-Kontrollampe
30. Steckdose für Handlampe
31. Anlaß-Druckknopfschalter
32. Deckenlampe
33. Tachometerbeleuchtung

35

Soft- and hardware evolution



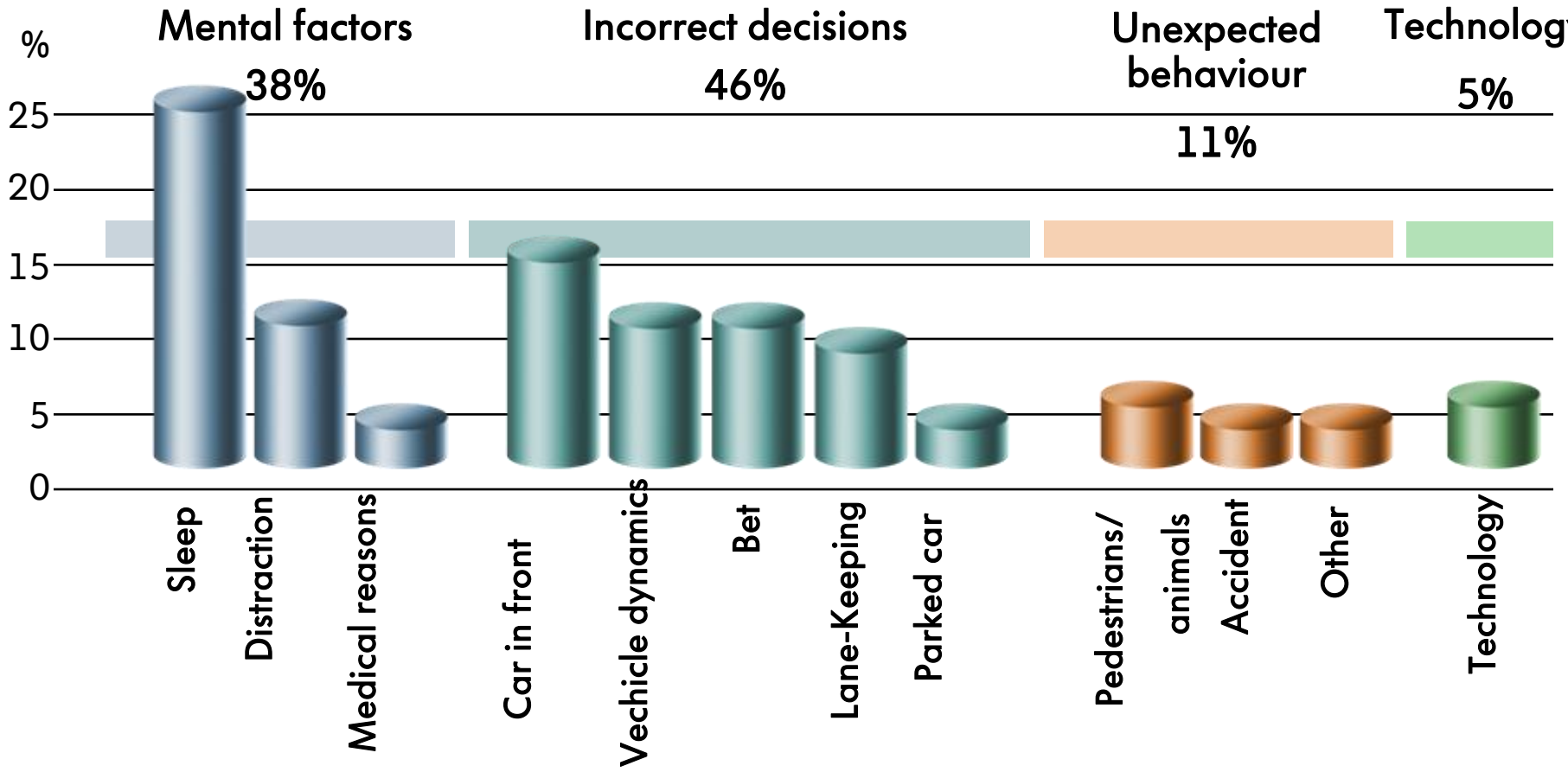
Example: gearbox CPU

The automobile of the future

The automobile of the future

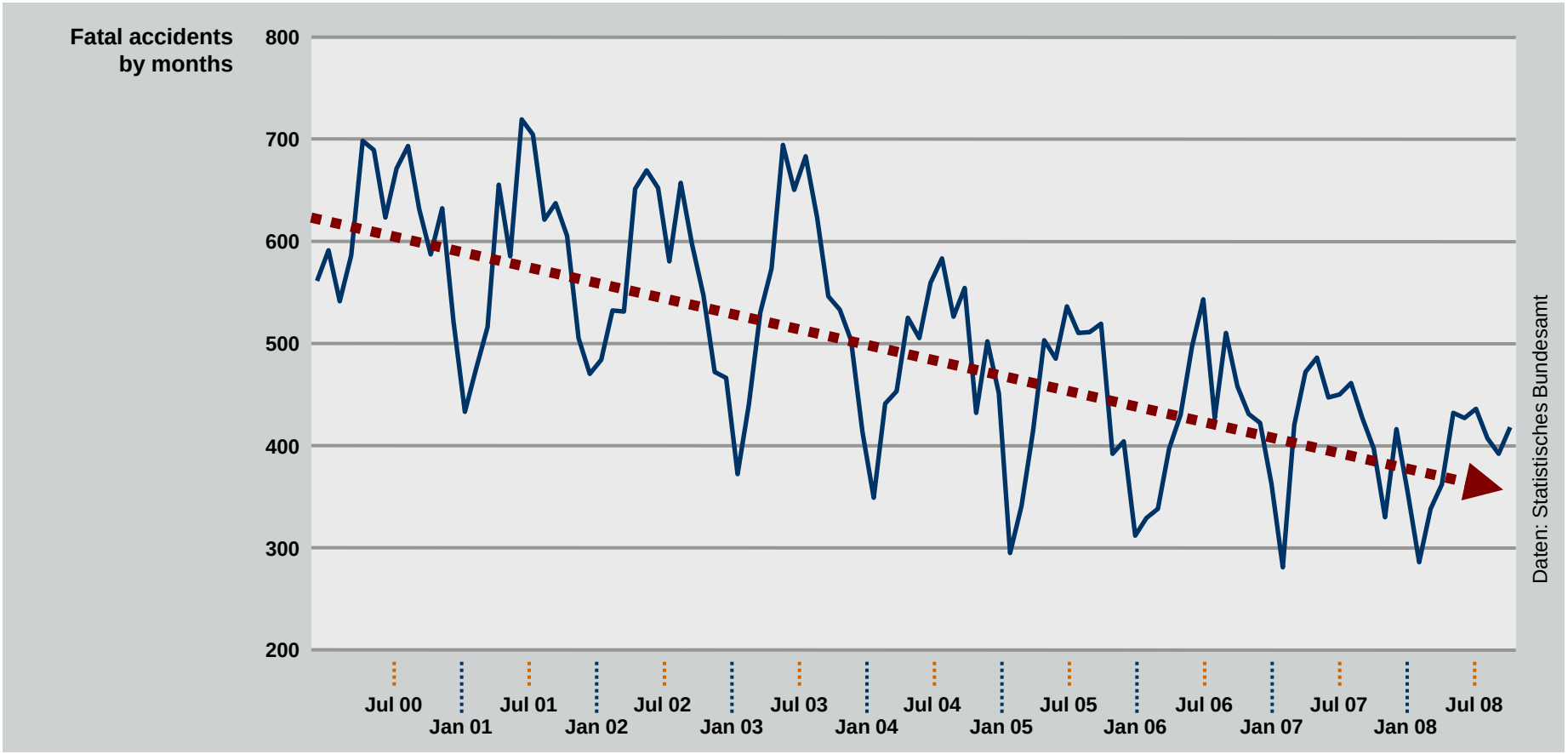
Driver assistance systems

Safety: The Driver as Uncertainty Factor
Causes of Fatal Accidents (84% misjudgement)



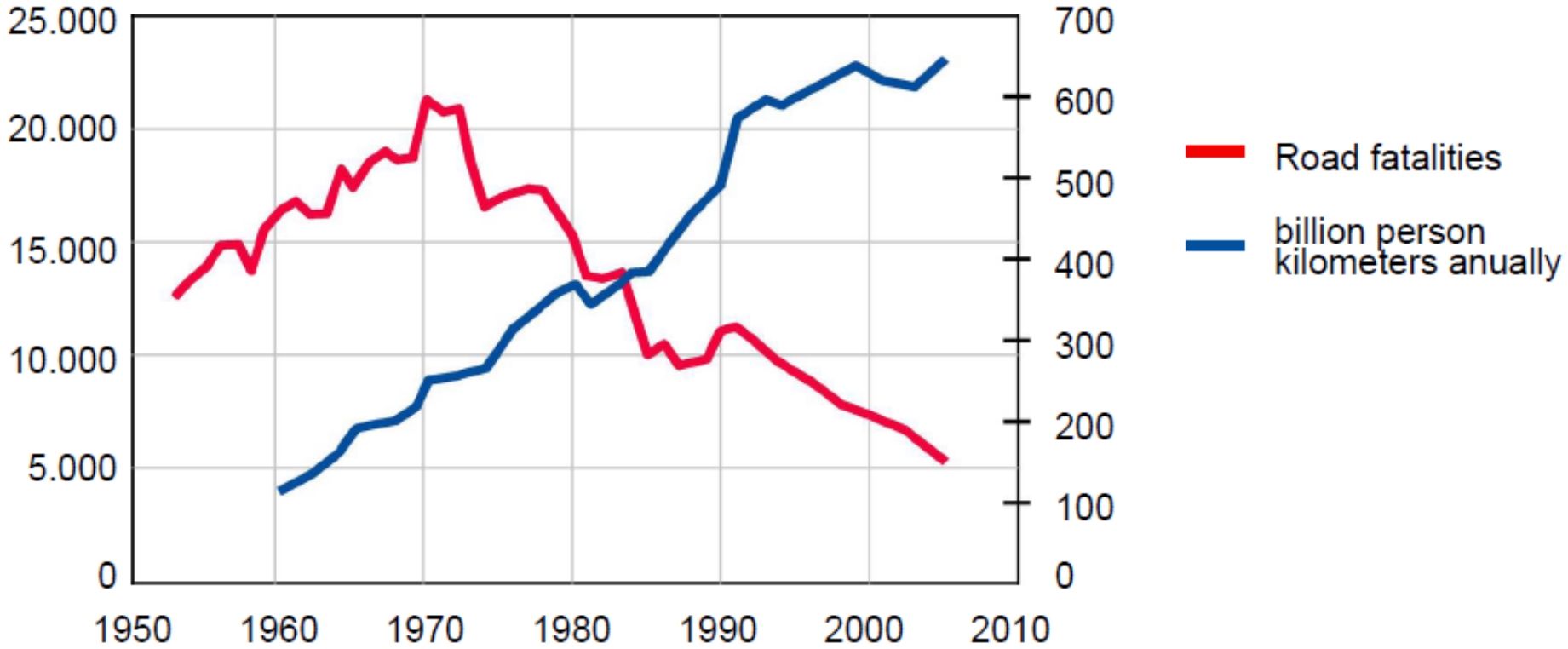
Quelle: GdV, VW Unfallforschung

Vehicle Safety
Fatal accidents over time (Germany)



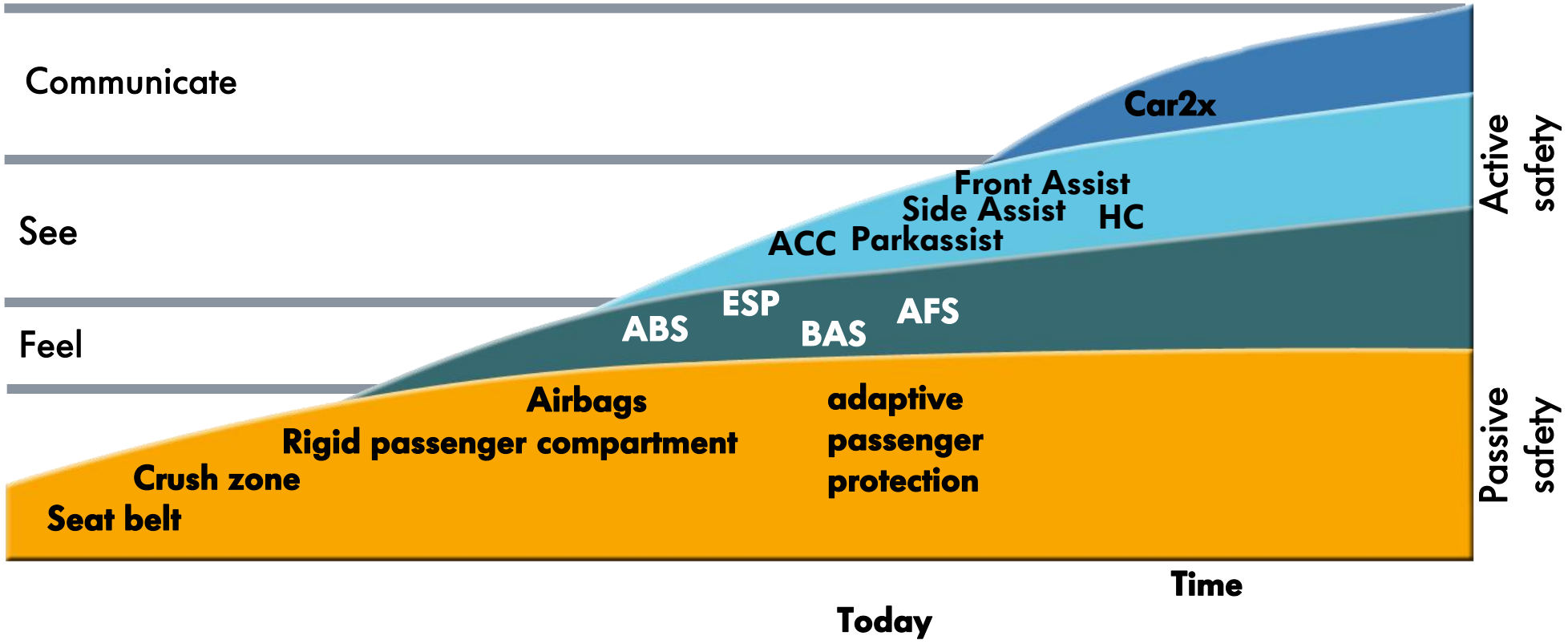
Road safety

Fatal accidents over time in Germany

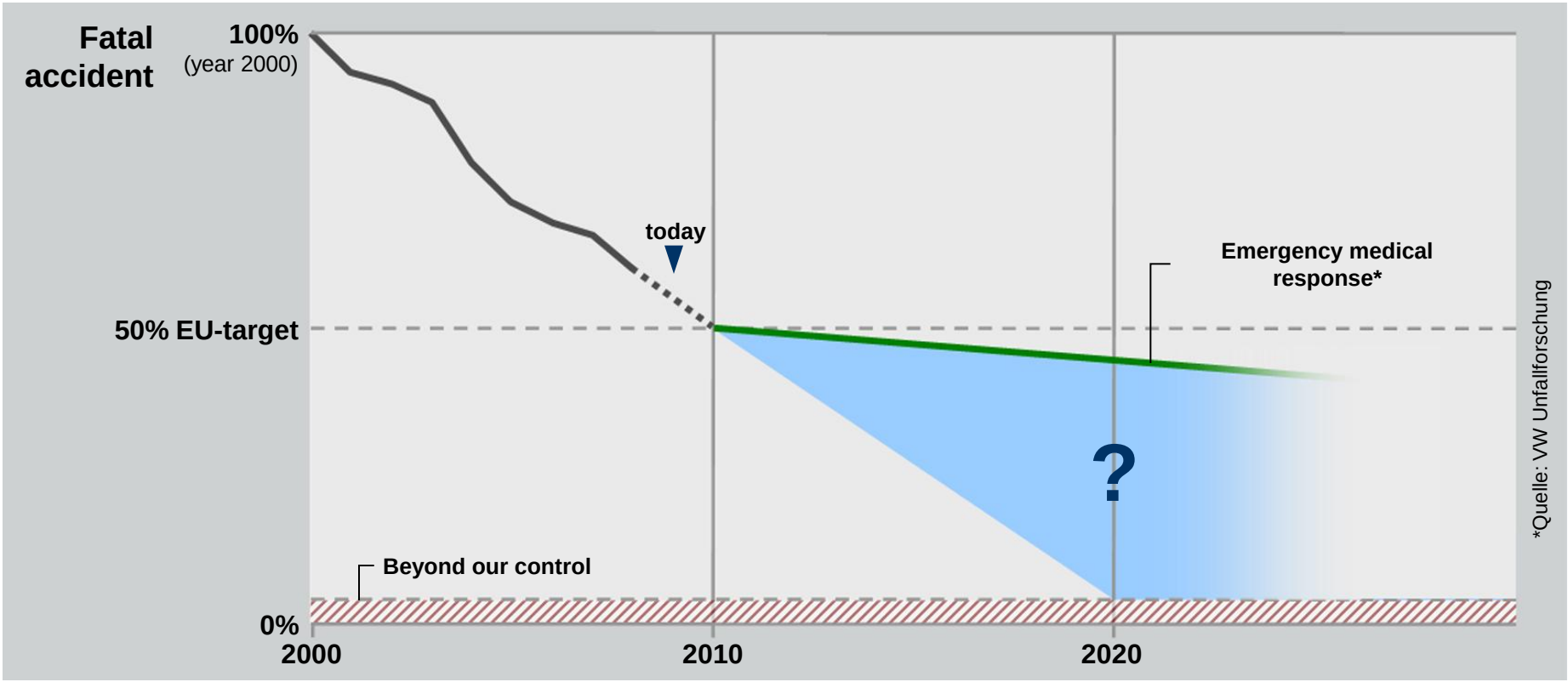


Quelle: Volkswagen AG - Forschung, Umwelt und Verkehr

Vehicle Safety - Potential for Protection



Effectivity of current assistance and saftey features



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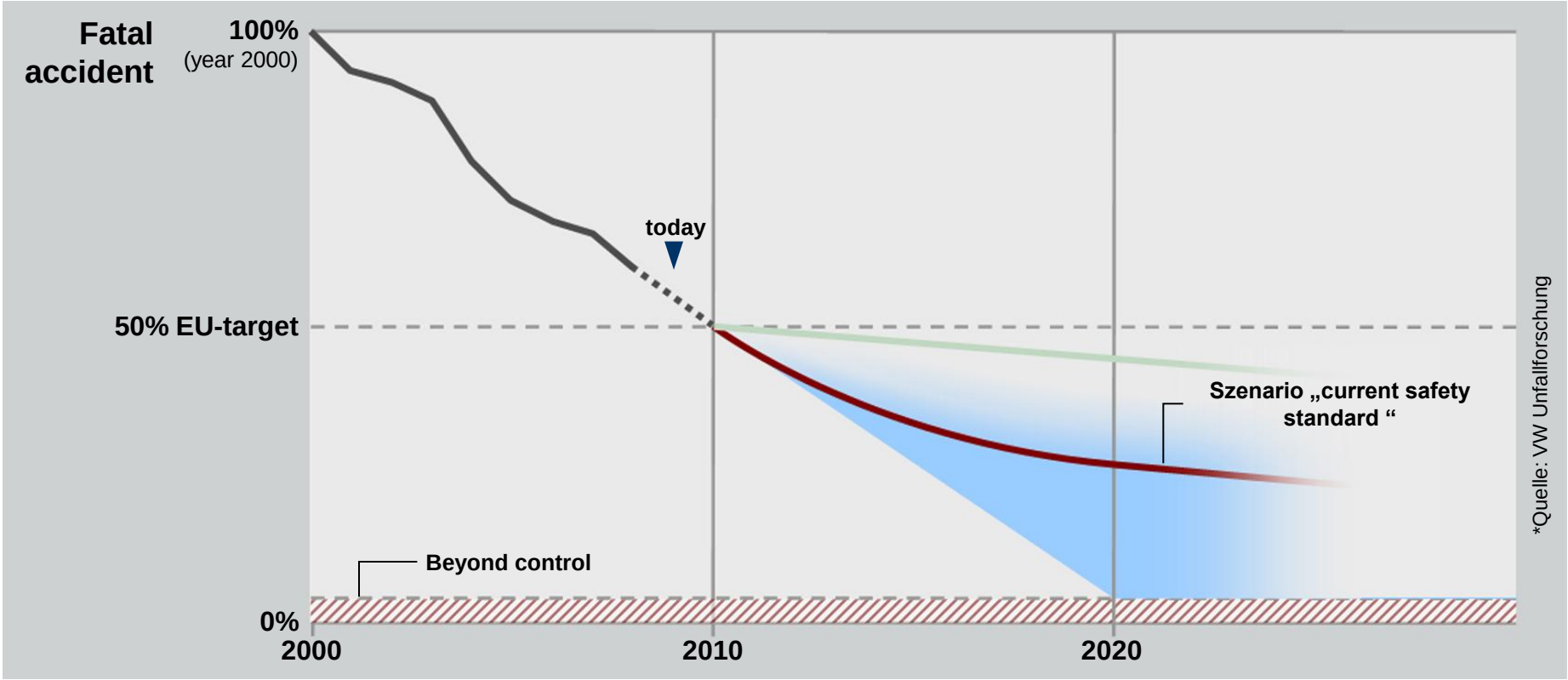
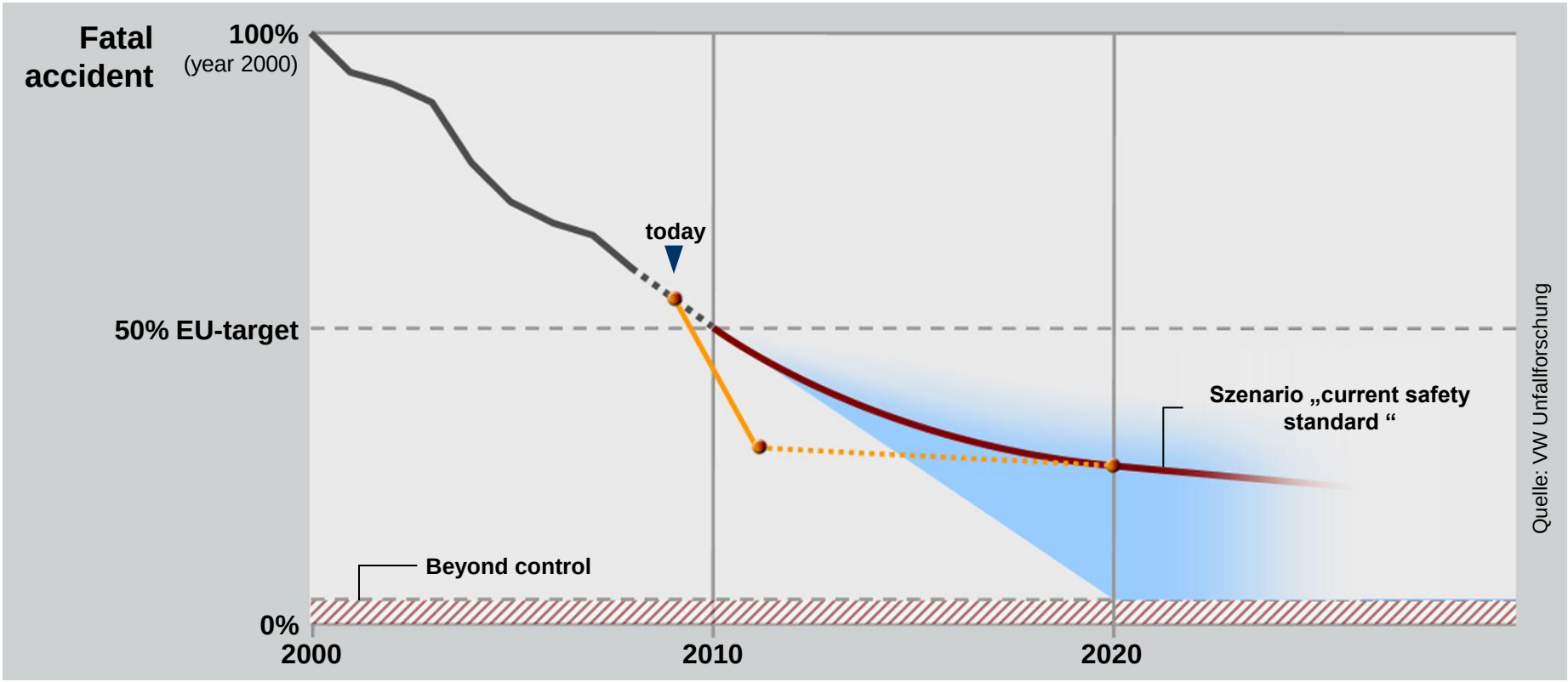


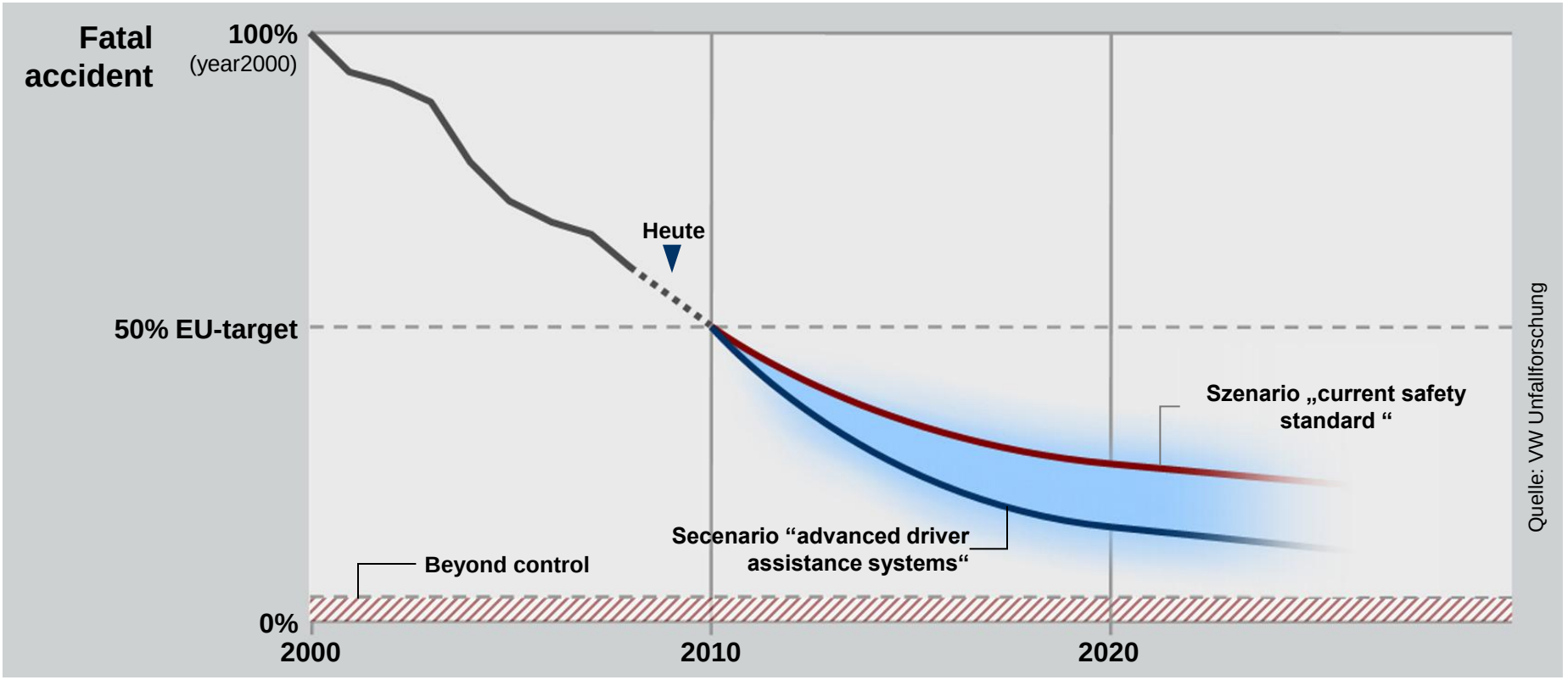
- With a consequent market distribution of available passive safety technology (Golf platform)

Effectivity of current assistance and saftey features



Special effects through incentive programs

Effectivity of current assistance and saftey features



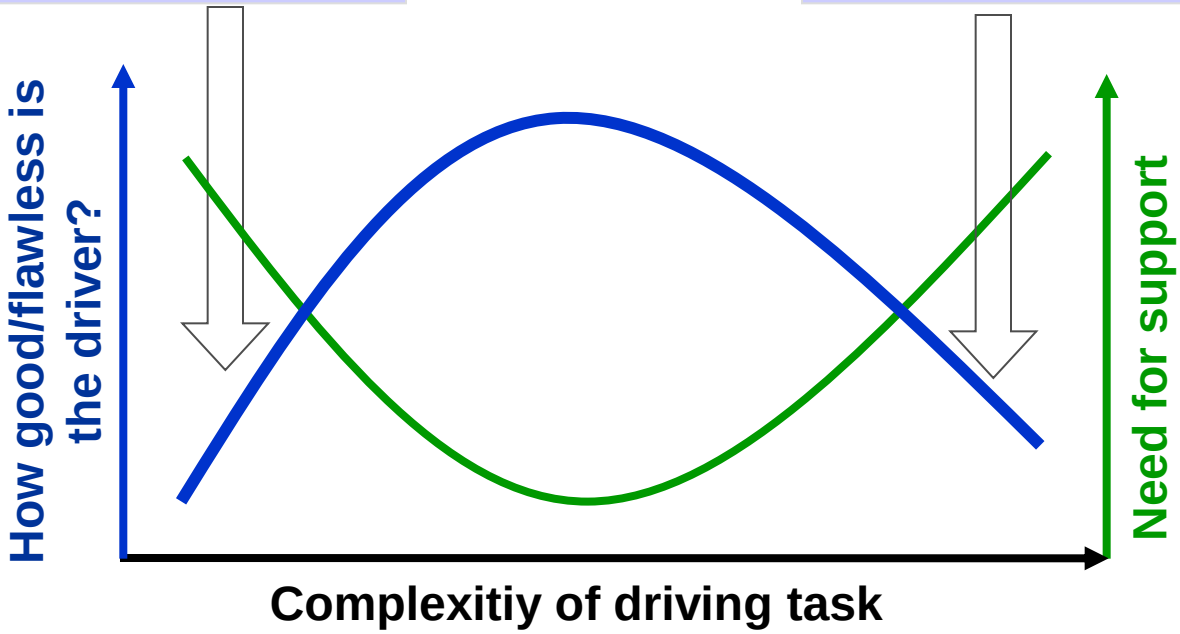
- Additional theoretical potential by 20% - with a consequent market distribution of advanced driver assistance systems

Increasing need for safety

Supporting the driver when he/she is in need of assistance

Under-challenging the driver
- Simple, monotonous driving tasks
- E.g.long distance trips, traffic jams

Over-challenging the driver
- Complex driving tasks
- E.g.entering a motorway, turning at intersections etc.



Customer Demands

In critical situations the driver needs assistance:

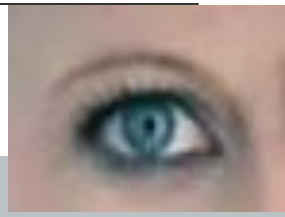
Safety Angel

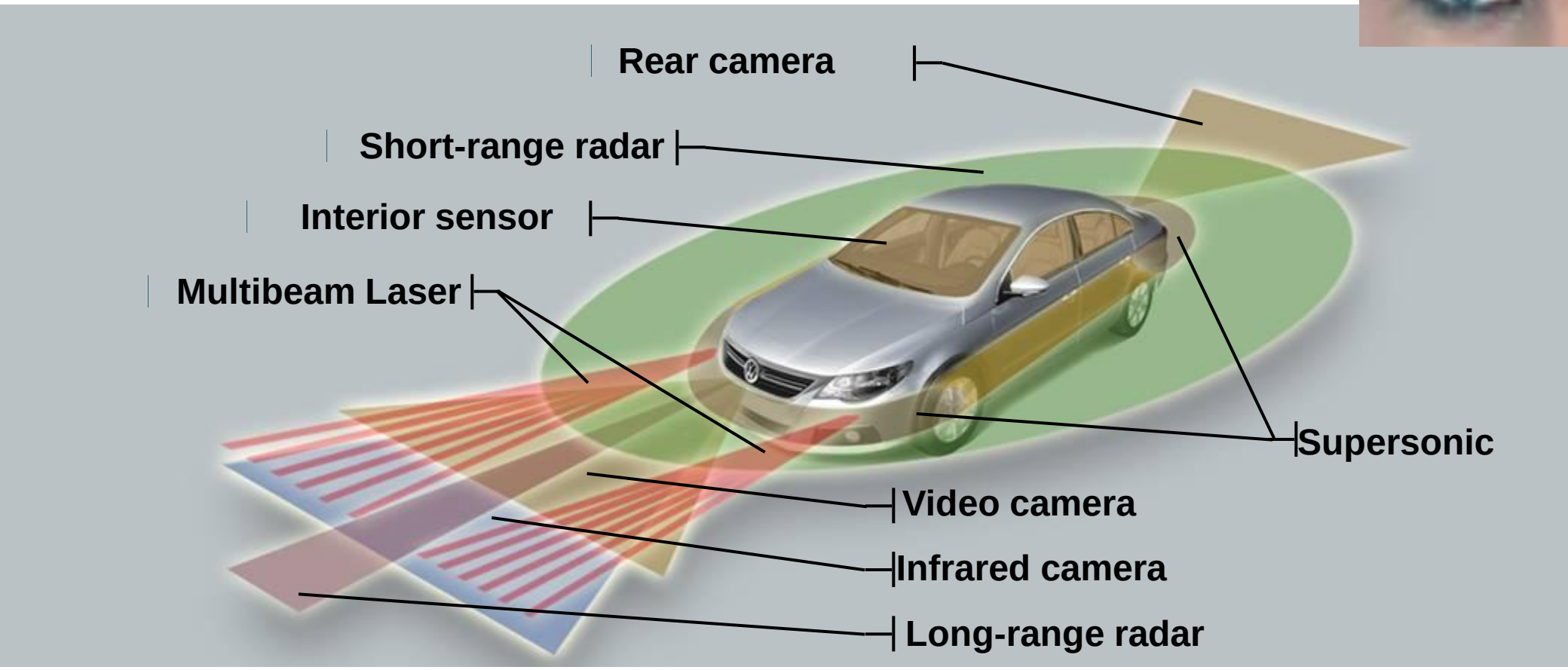
information
warning
assistance
up to automatic accident avoidance

In annoying situations the driver wants assistance:

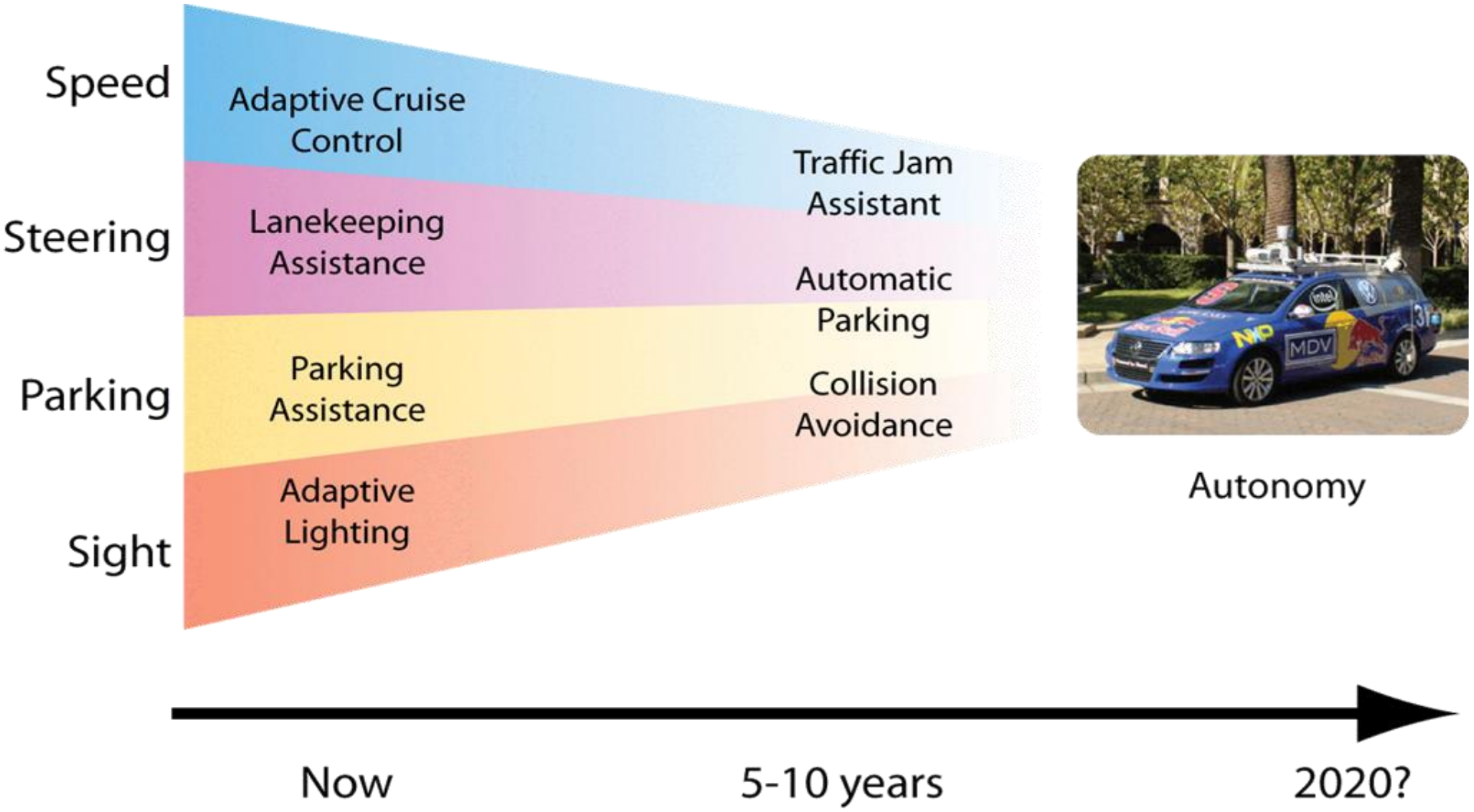
Autopilot

Sensors: Seeing like an Alert Person





Timeline of Driver Assistance



Building Block of Technologies

Driving at the limits of physics

- Vehicle dynamics
- Track coordination

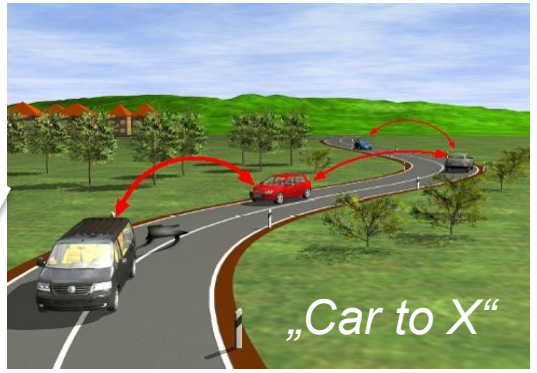
- Drifting algortithm
- High speed

Driving in unknown terrain

- Recognition of environment
- Locating
- Trajectory

Driving according to traffic regulations

- Driving strategy
- Complex environment



- Expanding the horizon
- Predict danger

Where is this project located

The pikes peak TTS is a key project at the Volkswagen Automotive Innovation Lab (VAIL) located at Stanford University, an initiative dedicated to promote innovation into automotive technologies.

Driving at the limits of physics (2010)

- Drifting algortithm
- High speed

Valet Parking (2010)

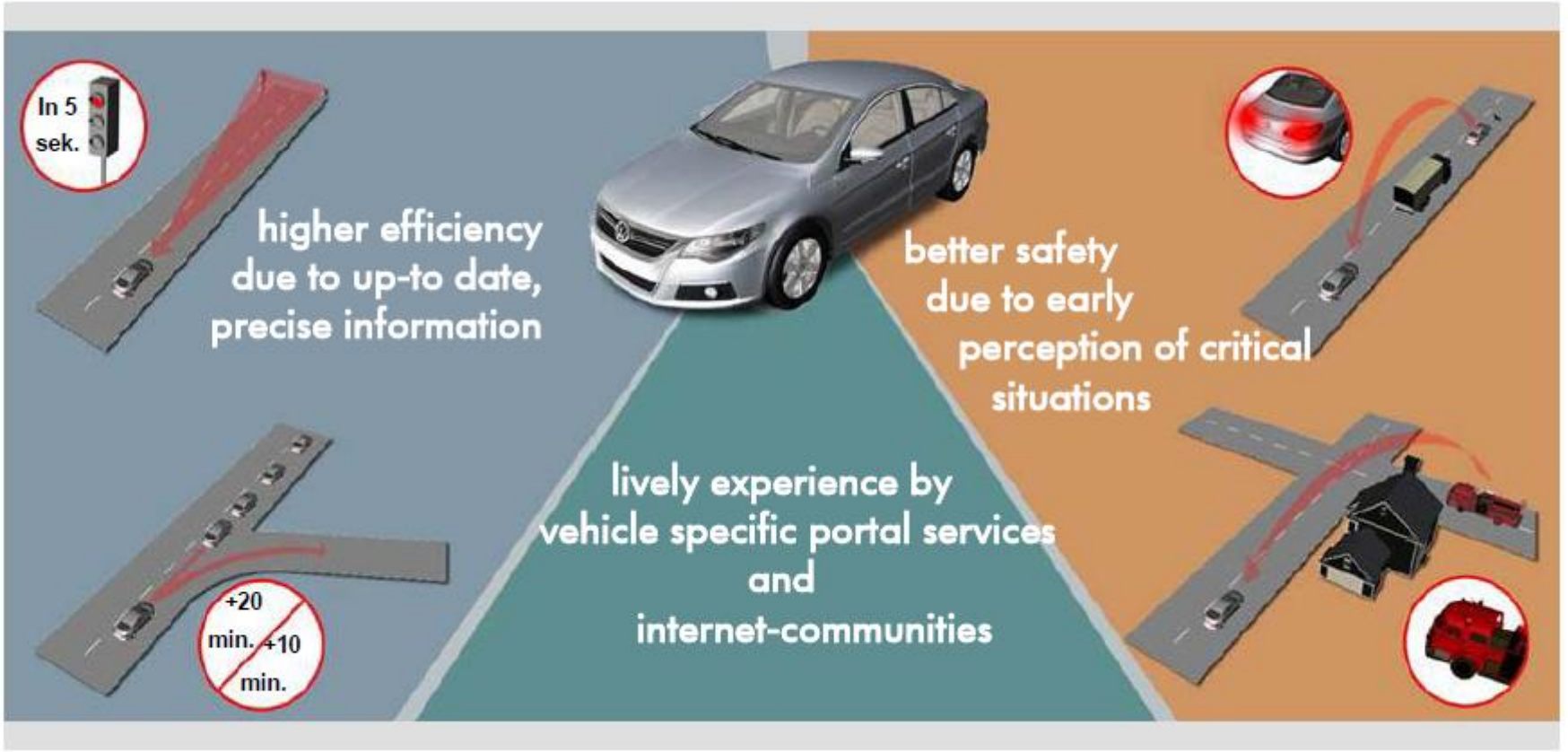
Driving according to traffic regulations

- Driving strategy
- Complex environment

Connected Car

Car to car communication in the past

Potentials of car to car communications



Improving traffic safety

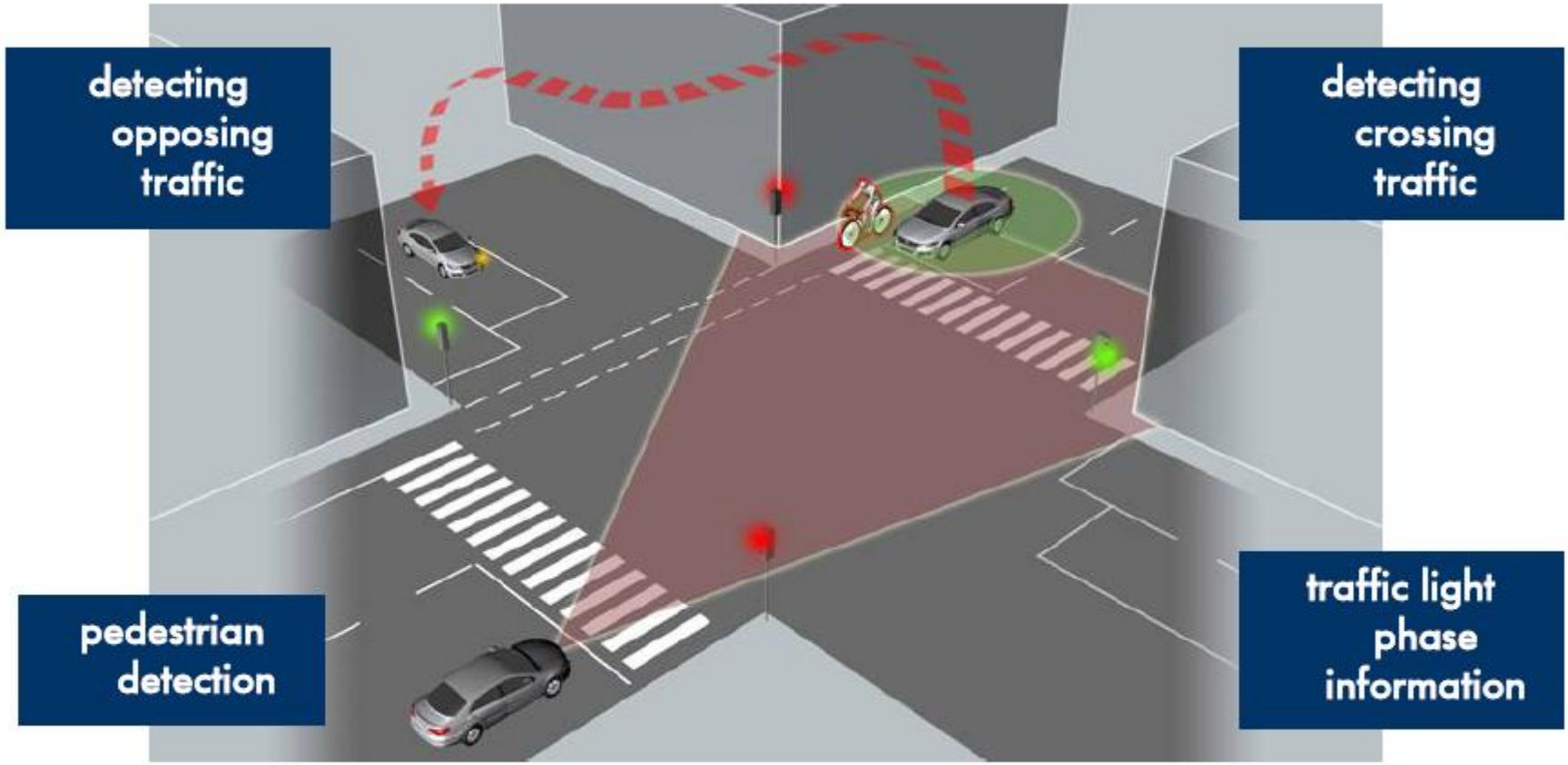
Information from an ambulance

In-car warning from traffic signs

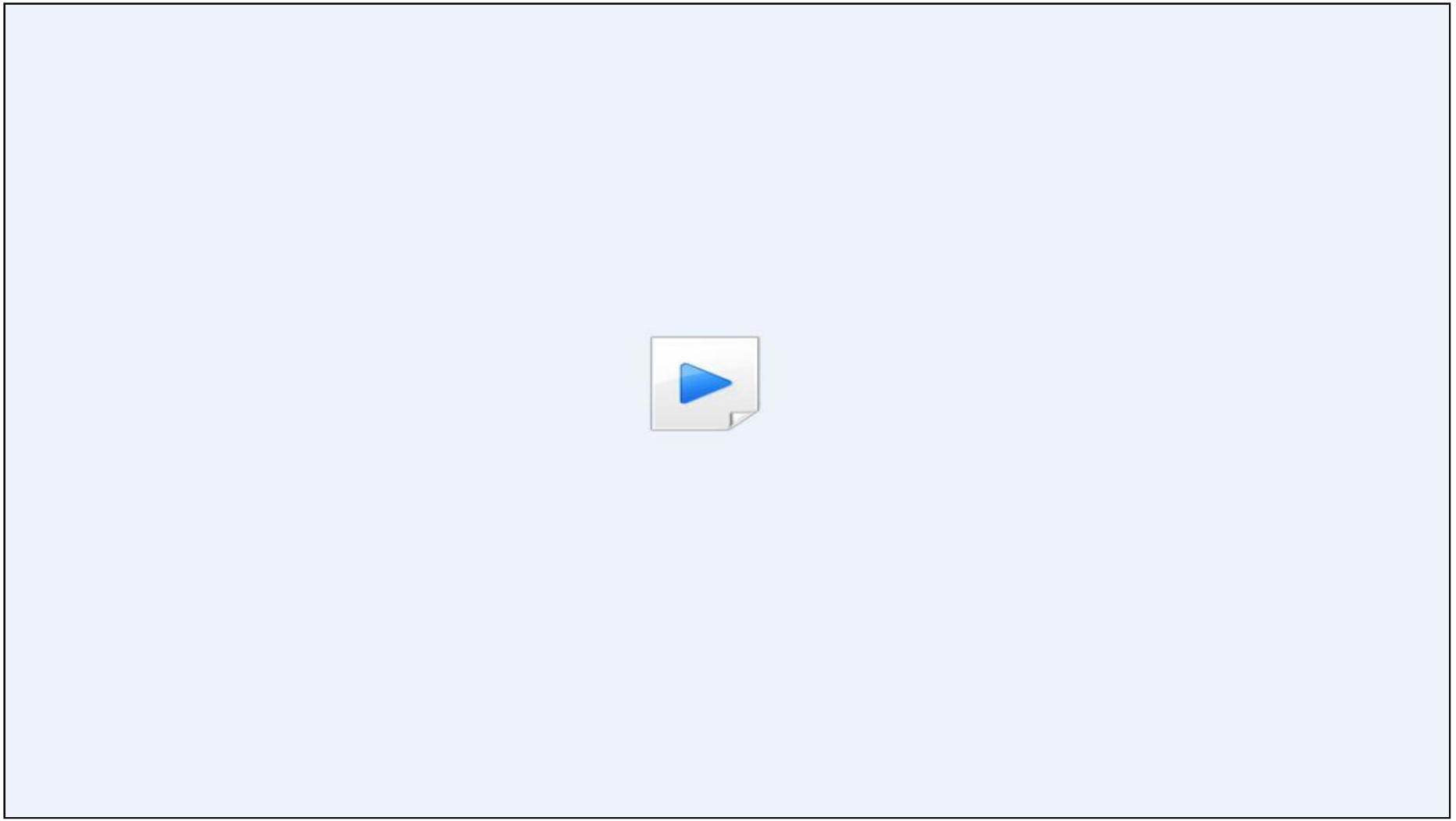
Bad visibility

Road works

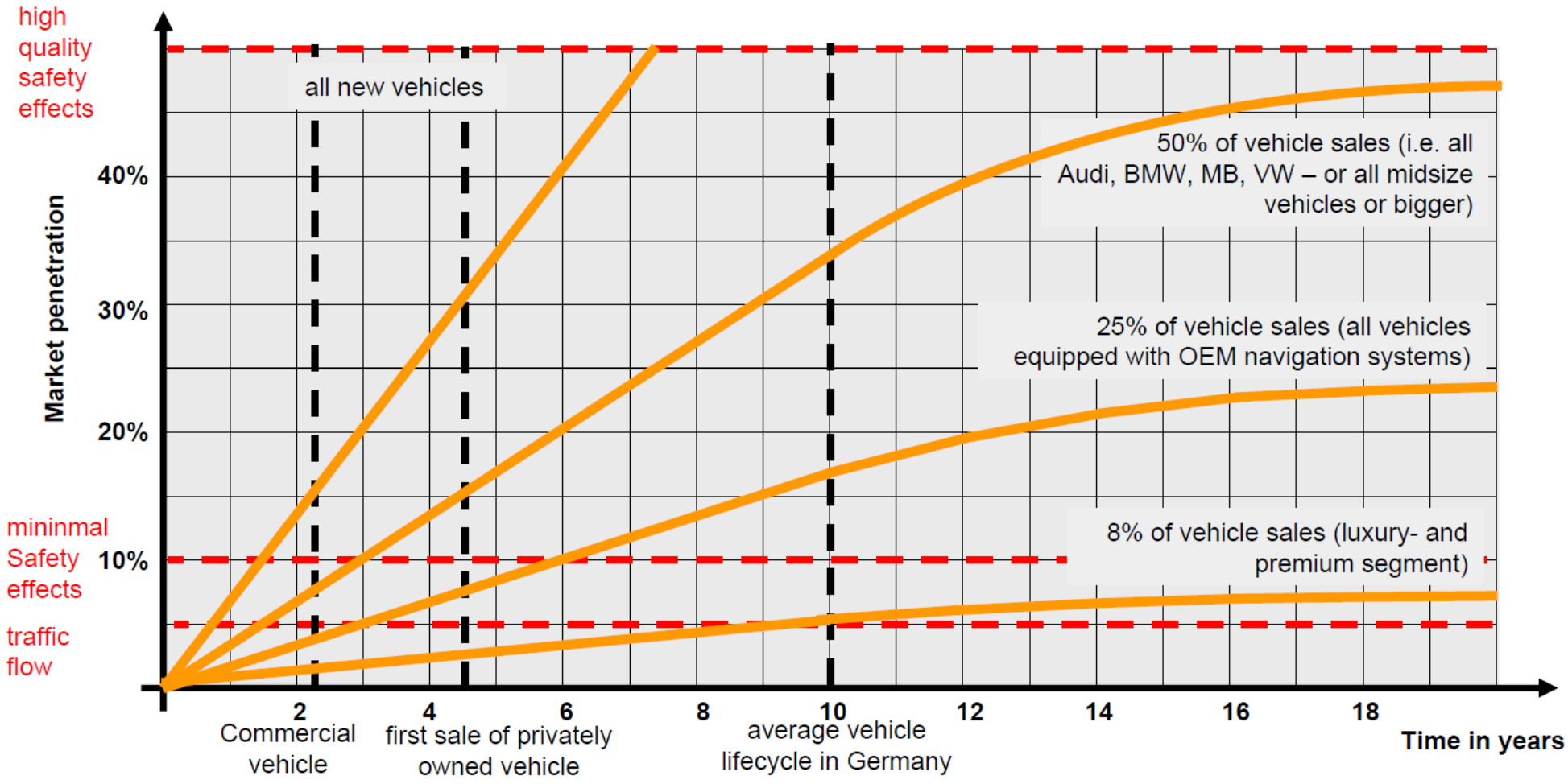
The intersection assistant



Car to x – expanding the horizon

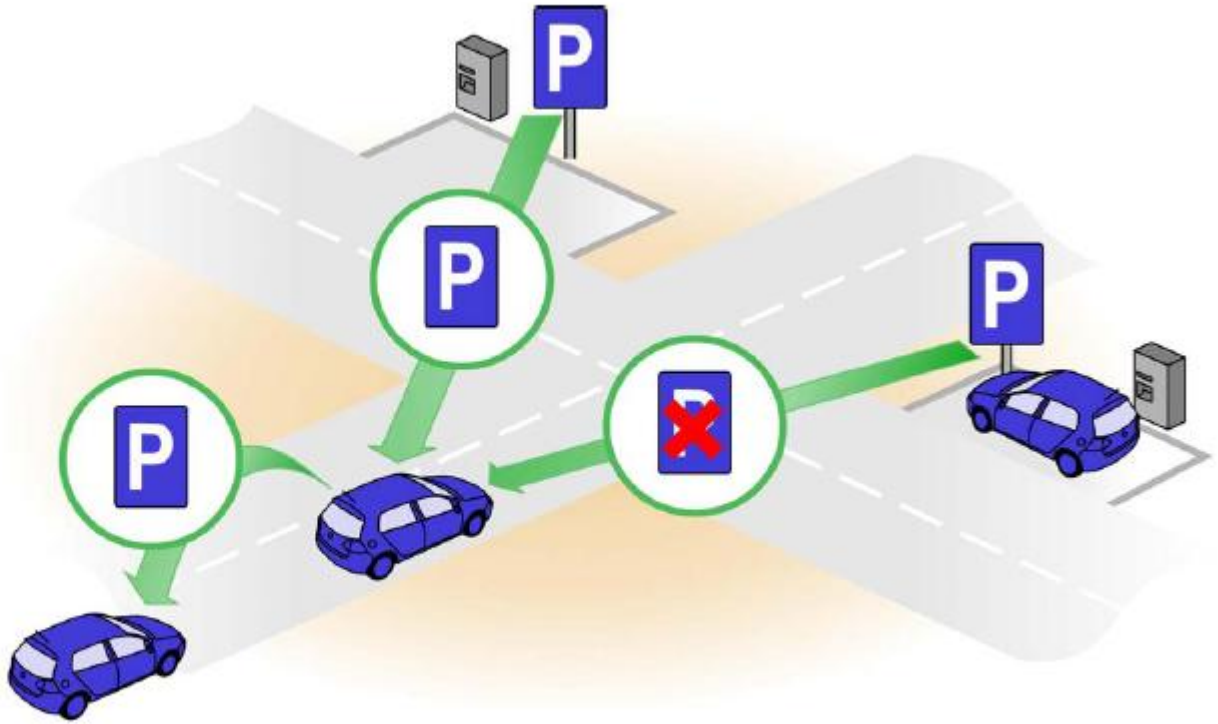


Market penetration is a key factor for car2x - technologies

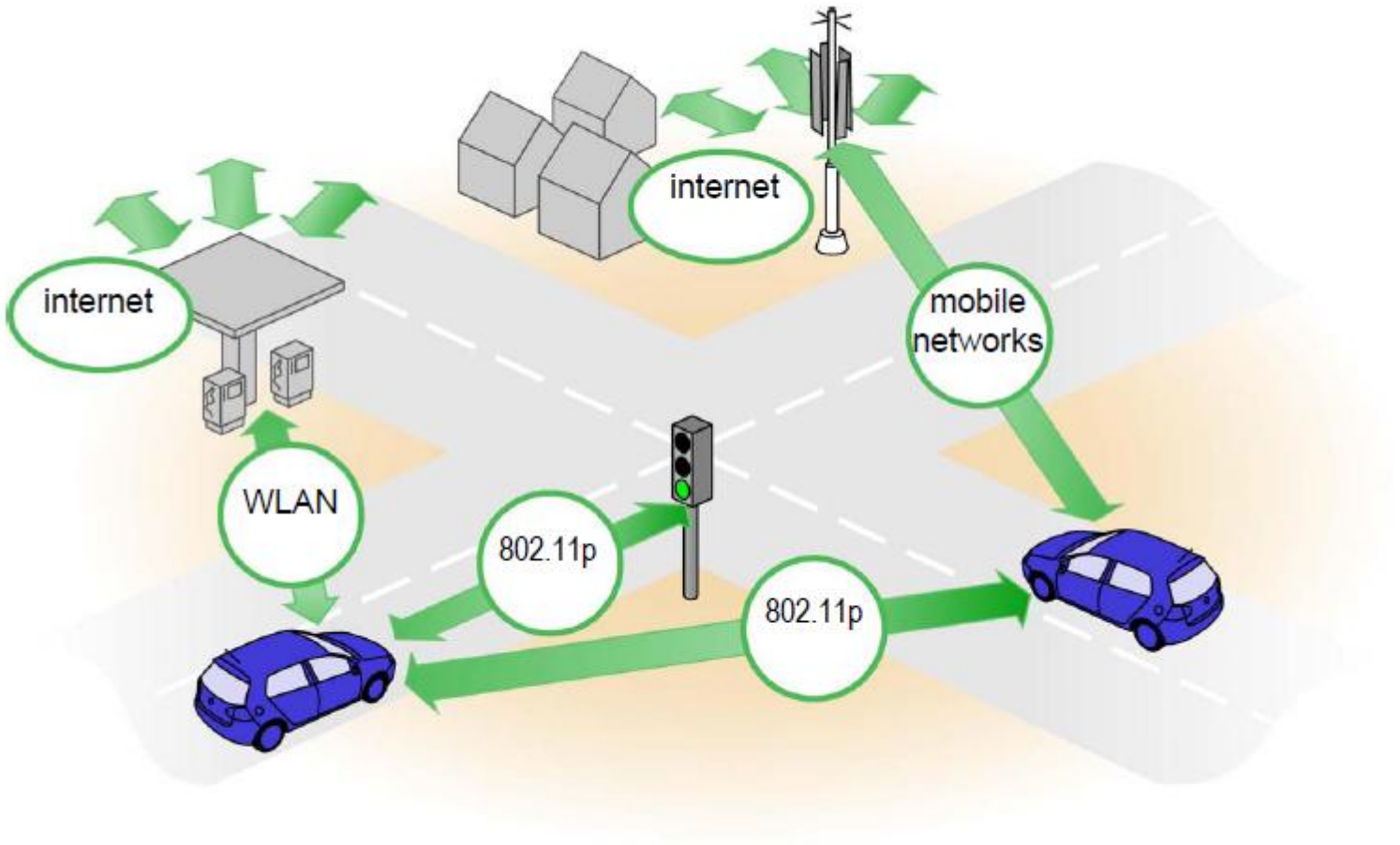


Find your parking lot fast

- Parking monitors transmit real-time parking lot use
- Vehicles transmit information on actual parking lot use
- 5% car2X equipment rate provides sufficient service quality



The vision – heterogeneous networks



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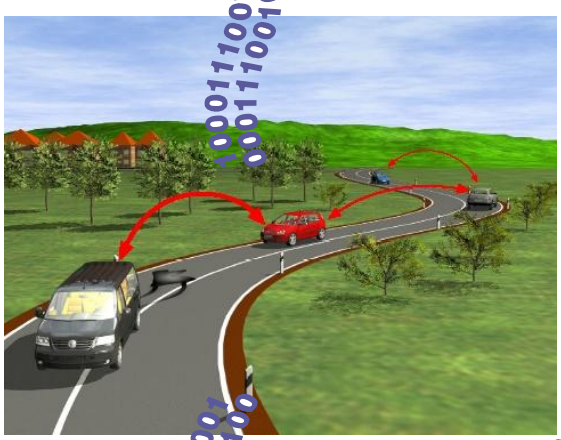
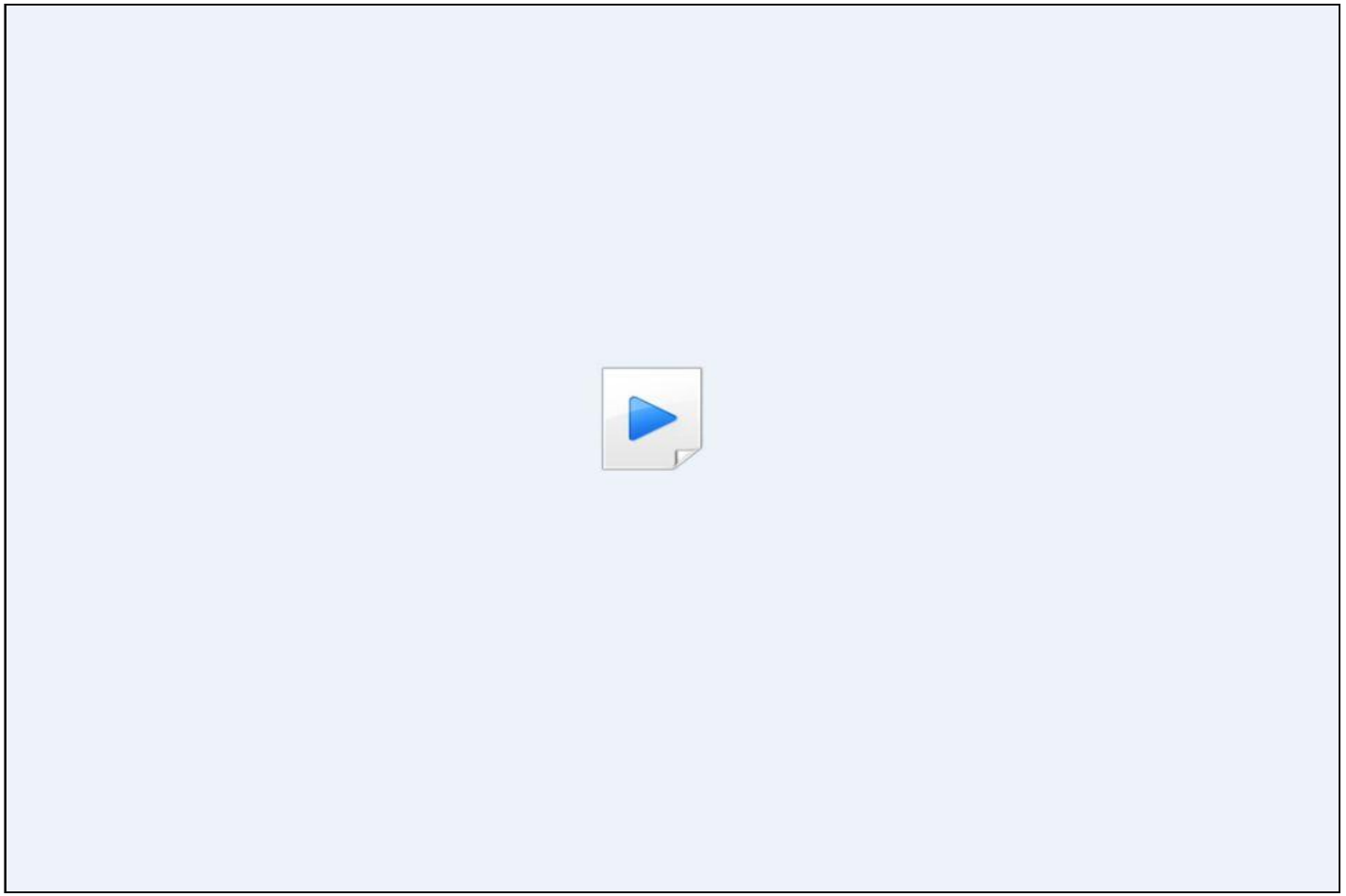
The Connected Car in a Connected World

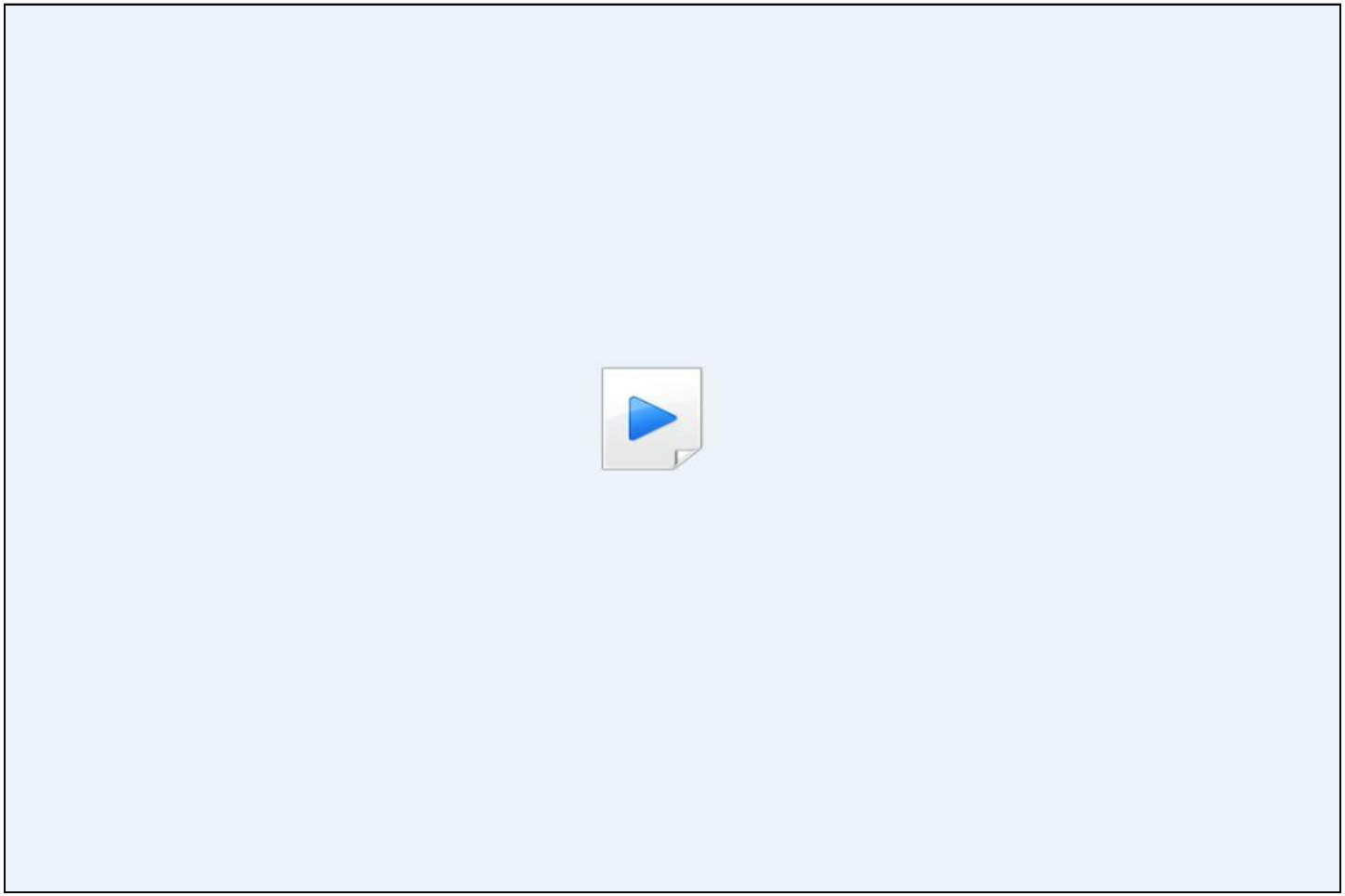


Human Machine Interface

Human Machine Interface – texting while driving



Human Machine Interface – distracted driving



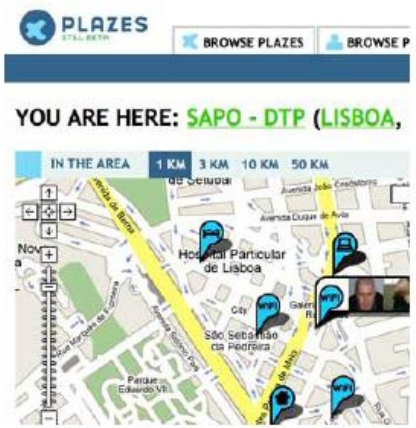
The Future of Human Machine Interfaces

	Customer	Basis	Challenge
	**Basic driving functions:** • well known for decades • learnt in school	standard	**automatic driving** **reliable assistance**
	**New systems z.B. DAS, hybrid:** • unfamiliar to customers	safety relevant	**differentation via HMI** **combination of DAS and DIS**
	**Infotainment, navigation, audio, telephone, etc. :** • well known	High expectations: function, look&feel, interaction	**new dialog models** **software/ responsibility**

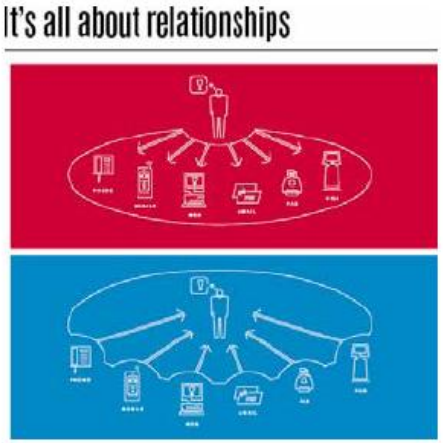
Infotainment Evolution

openstreetmap.org

plazes.com



facebook.com



location based services

social networks

Who is the competition?

new technologies

Integration of online internet services

Traffic information

Fuel prices

Time tables

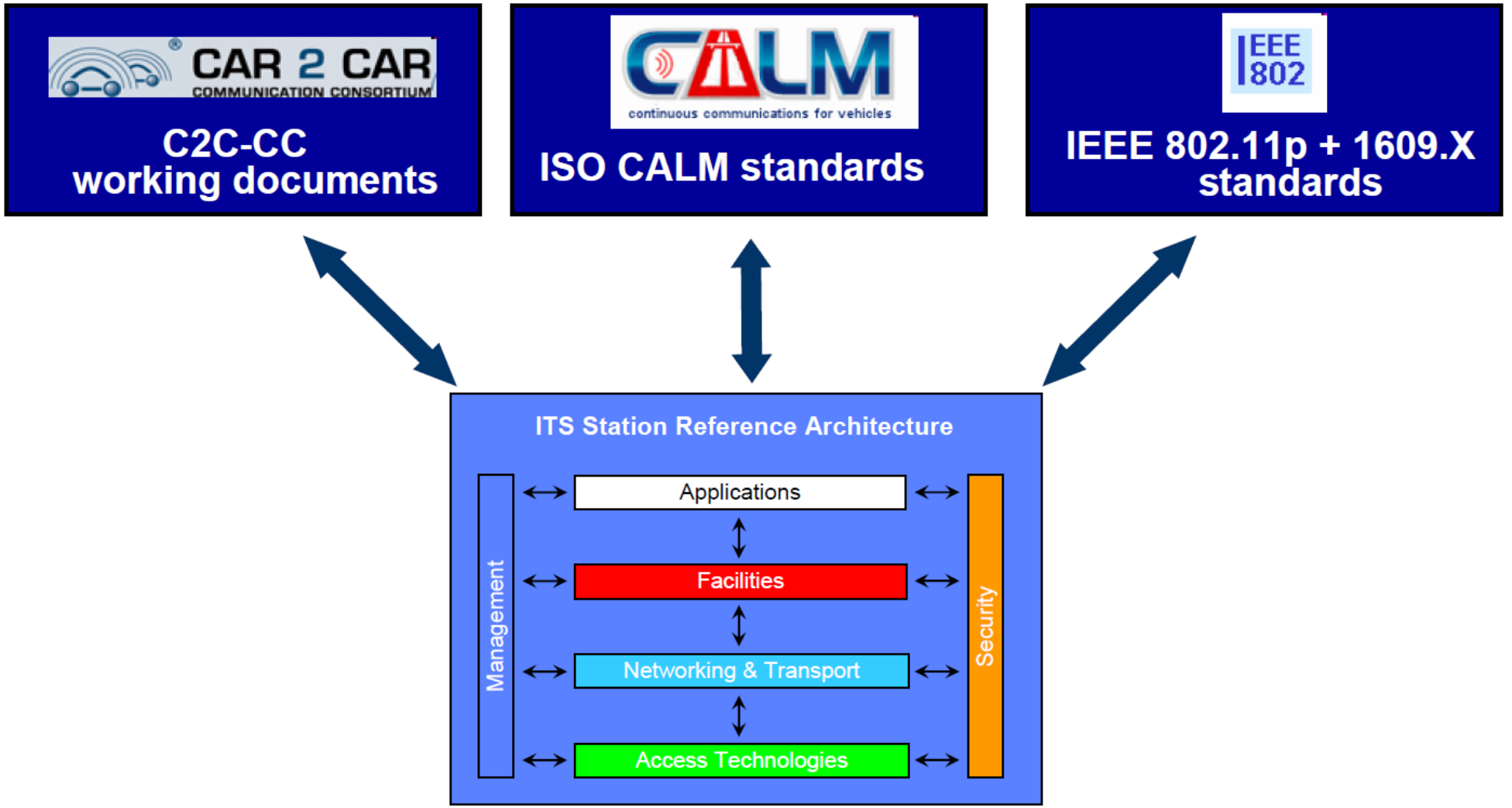
Restaurants and hotels

Tourist information

Current events

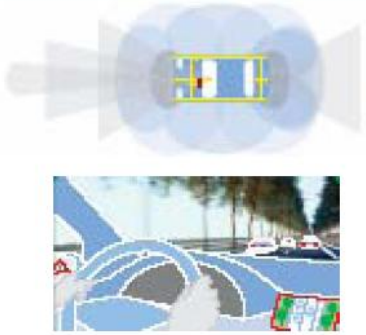
Driver information with backend services

Harmonization of world wide ITS standards is mandatory



Only integrated systems will provide an acceptable solution

intelligent vehicles



communication (Car2X)

efficient traffic management

move

Traffic of the future

intelligent infrastructure


Somebody sent me a text ...
What did he write?
Drive, you fool!
Signal is green!

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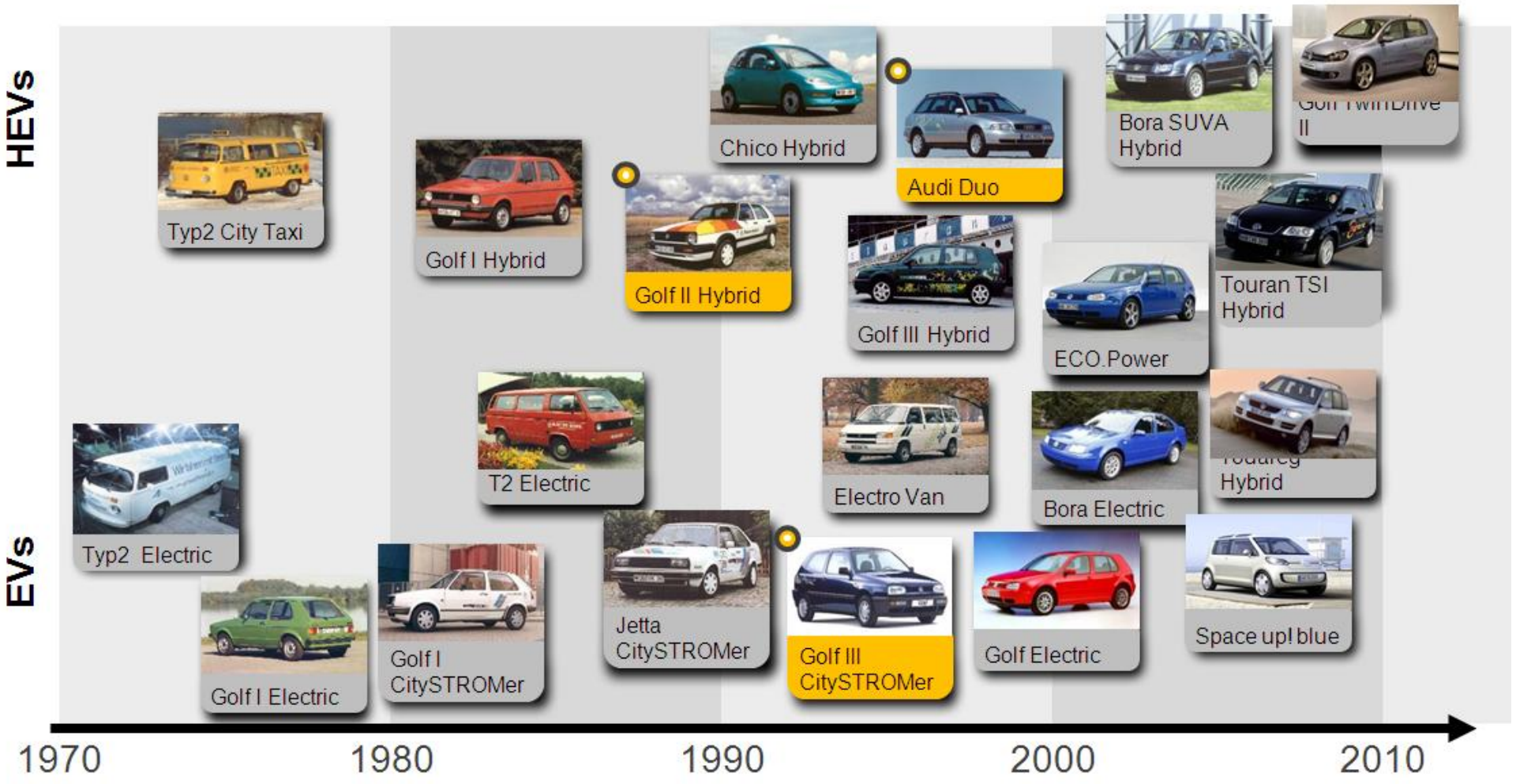
eMobility

EVs and HEVs



eMobility

1973 VW electrical bus

- BEV
- Electric power 17 kW

1993 VW Golf City Stromer

- BEV
- Electric power 25 kW

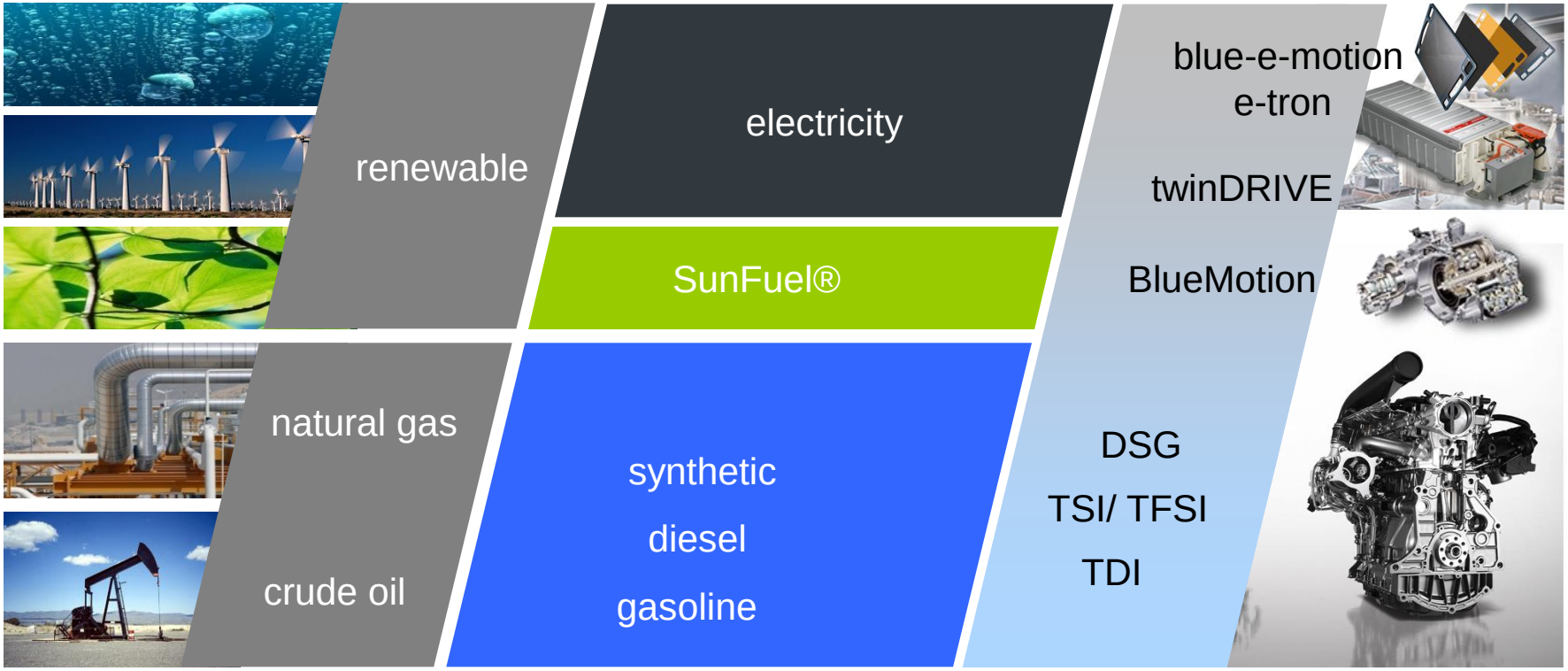
1991 Study VW Chico

- Hybrid
- Electric power 25 kW + 7 kW

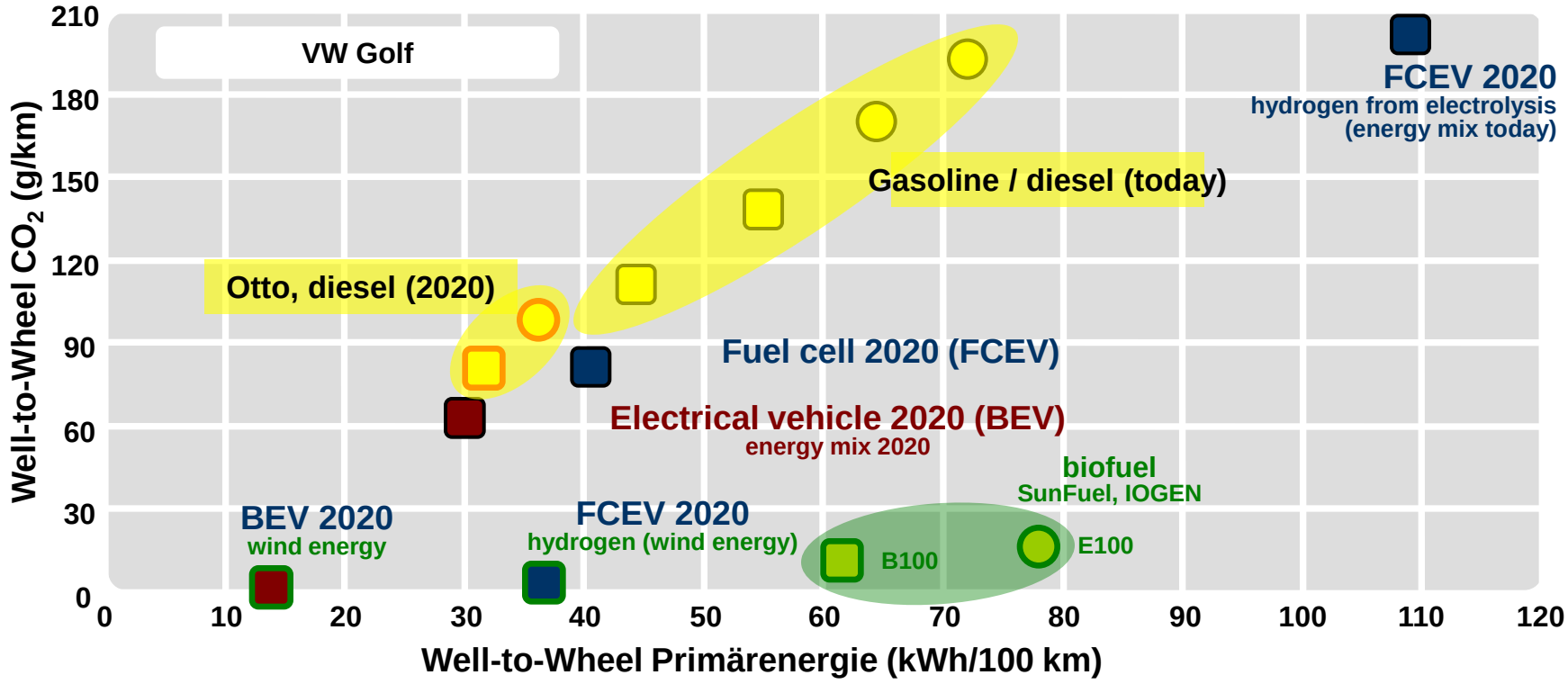
2007 Study VW Space Up! blue

- Fuel cell
- Electric power 45 kW

Drive train and fuel strategy

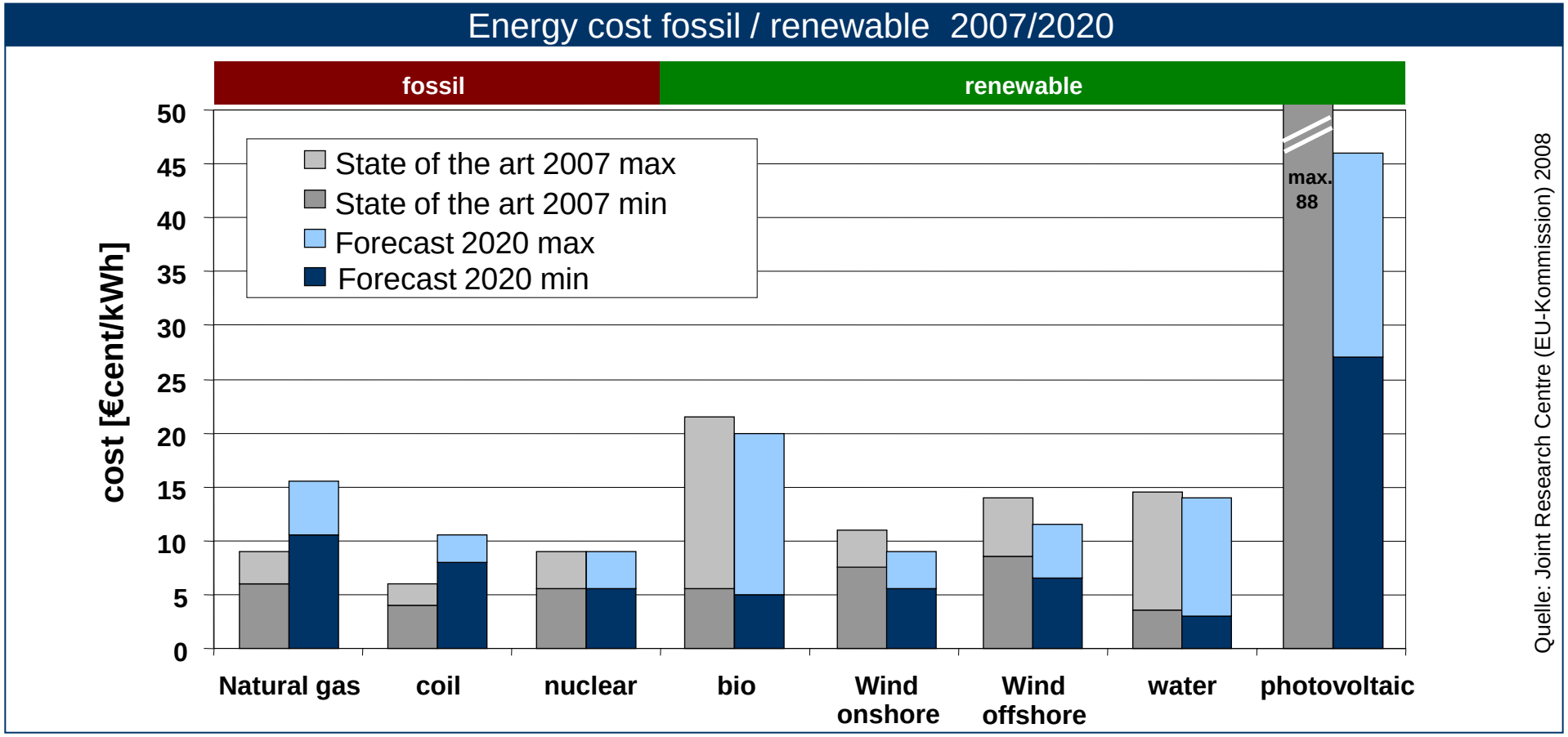


CO_2- and energy efficiency (power train) (until 2020)

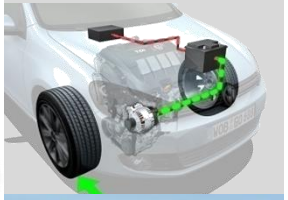


Electrical vehicles - highest potential concerning CO_2- & energy efficiency depending on the energy generation process

Energy Cost



electrification

Combustion engine	Mild hybrid	Full hybrid	Plug-in hybrid	Electrical vehicle
• 1.2 l 77 kW TSI 	• start/stop system • recuperation  	• Touareg Hybrid 	• Golf twinDRIVE 	• Up! blue-e-motion 

Energy storage: technologies and requirements

	Combustion engine	Mild Hybrid	Full Hybrid	Plug-in Hybrid	Electrical vehicle
	• Start engine	• start-stop • recuperation (boost)	• start-stop • recuperation (boost) • (e-Drive, 2 km)	• start-stop • recuperation (boost) • e-Drive, 20 km	• e - range > 100 km
Energy storage					
Electric power	~ 2 kW	~ 6 kW	~ 15 kW	~ 30 kW	~80 kW
capacity		< 1kWh	1 – 2 kWh	10 – 15 kWh	>25 kWh
voltage		12 V	< 60 V	> 60 V	>> 60 V
durability	5 years		8 - 10 years		>10 years
Technology					
Lead acid					
Nickel metal hydride					
Lithium-Ion					

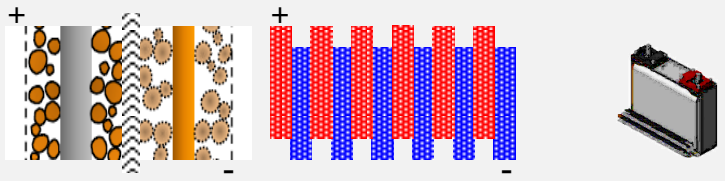
Cell format

High power
„100-m“

High energy density
„marathon“

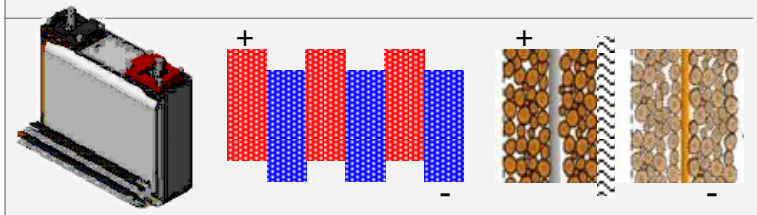
Hybrid ⟷ Plug-In Hybrid, electrical vehicles

- High specific power
- low specific energy
- Small cells, thin, porous electrode



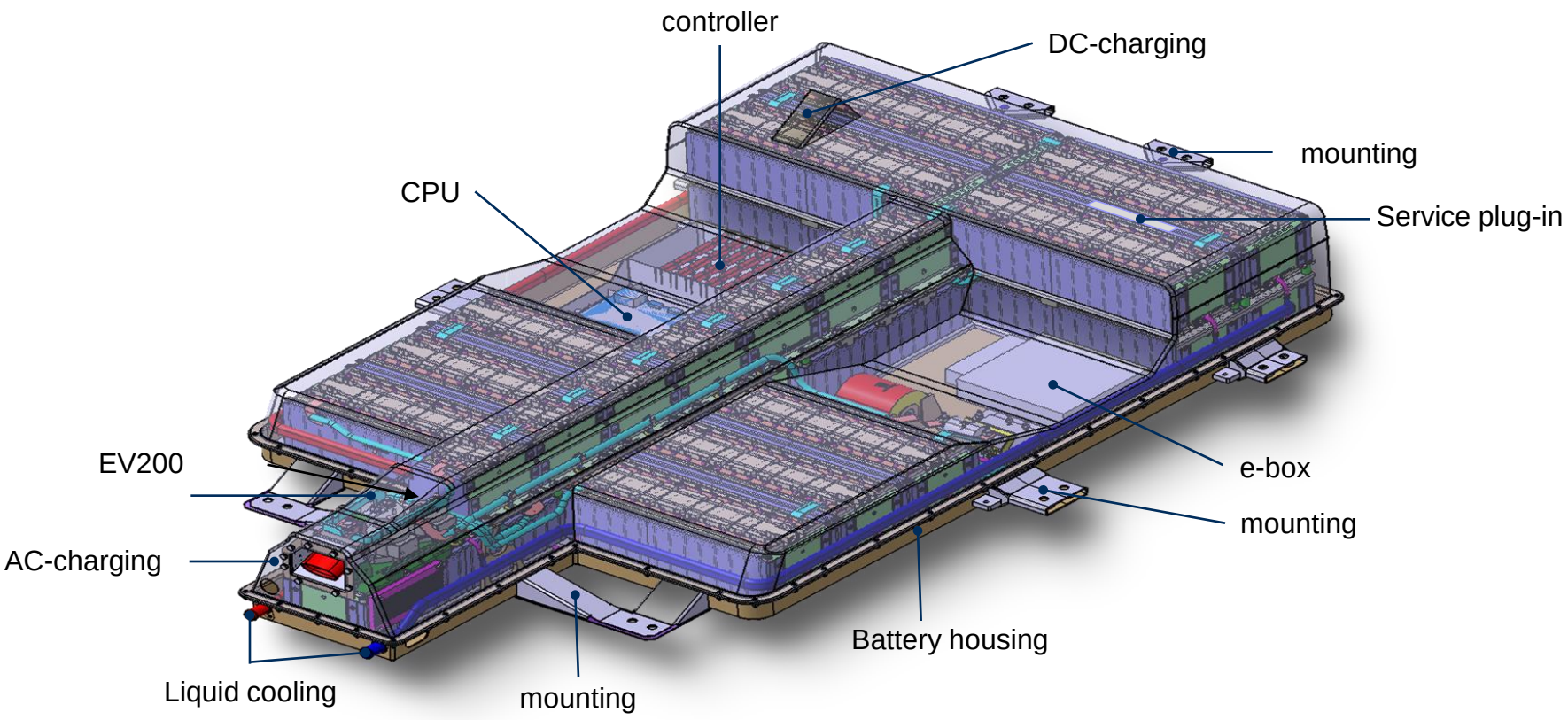
capacity:	5 Ah
mass/vol:	0.25 kg, 125 cm³
energy:	18 Wh (80 Wh/kg)
spec. power:	500 W (> 2.000 W/kg)

- High specific energy
- Low specific power
- big cells, thick, dense electrode



capacity:	50 Ah
mass/vol:	1.2 kg / 750 cm³
energy:	180 Wh (150 Wh/kg)
spec. power:	800 W (700 W/kg)

Battery system



Volkswagen Group is evaluating several battery concepts

18650 Cells

Large Cylindrical Cells

Large Prismatic Cells

Large Pouch Cells

Performance Vehicles

High-volume Production Vehicles

New City Vehicles

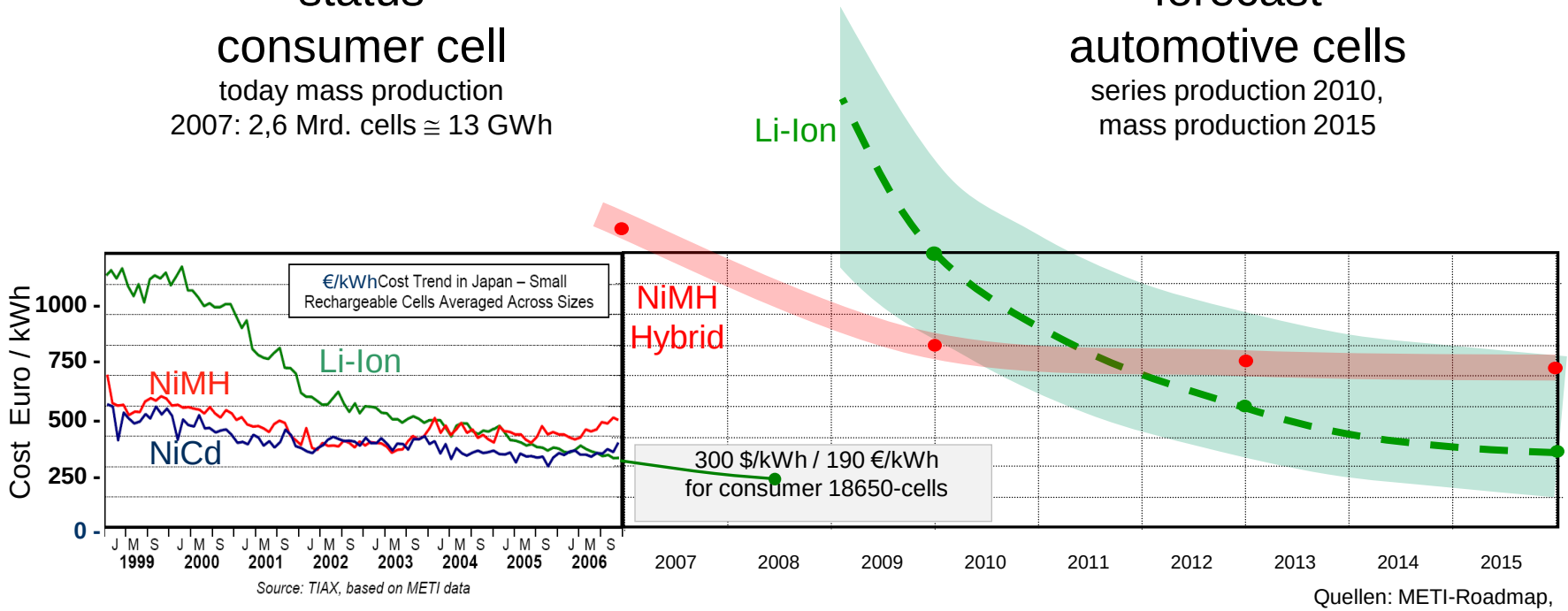
market and cost – li Ion cells

status consumer cell

today mass production
2007: 2,6 Mrd. cells ≅ 13 GWh

forecast automotive cells

series production 2010,
mass production 2015



Exchange rate
1,50 USD = 1 €

Quellen: METI-Roadmap,
AABC,

Challenge: charging time

Gasoline

Pump nozzle: 27.000 kW
(~ 50 l/min)

→ 1 minute = 1000 km driving range

VS.

electricity

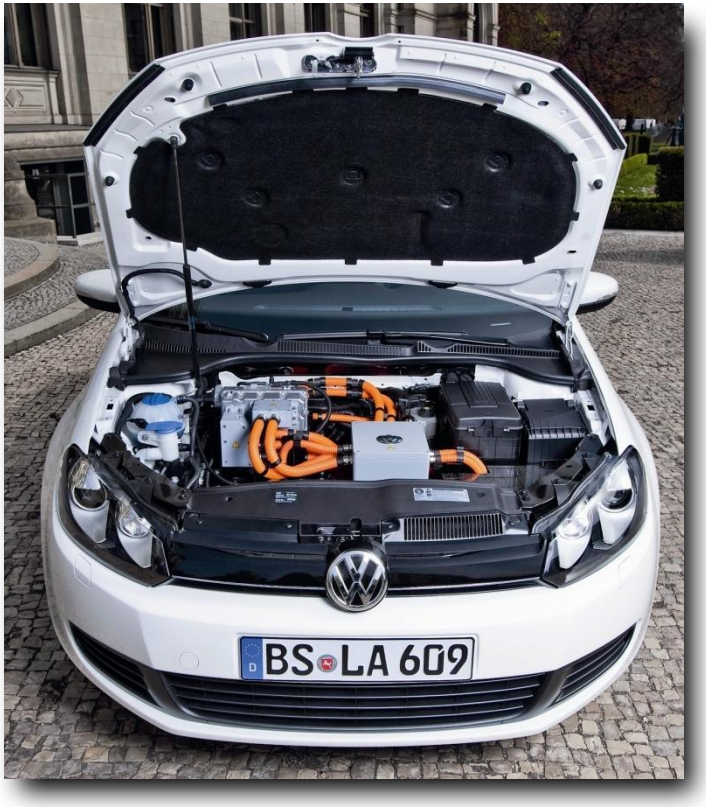
Three-phase: 10 kW

→ 1 minute charging = 1 km driving range

concept Golf! blue-e-motion

Vehicle data	
Vehicle weight	1545 kg*
* 205 kg more than Golf Blue Motion TDI with DSG	
Dimensions L/ B/ H	4199/ 1786/ 1480 mm
Gearbox	EQ 210 (1-Gang-Getriebe)
Maximum speed	135 km/h
Acceleration (0-100)	11,8 s
elektr. Driving range	up to 150 kilometer

Power train	
E-motor	85 kW / 115 PS
battery	26,5 kWh (Li-Ion)
voltage	324 V
torque	270 Nm



Thank you for your attention!

Pikes Peak TTS: „Autonomous Hill Climbing“